

EVALUATION OF ENHANCEMENT OPPOR-  
TUNITIES FOR RAINBOW TROUT (*Salmo gairdneri*)  
AND DOLLY VARDEN CHAR (*Salvelinus malma*)  
SPORT FISHERIES IN BIG LAKE, ALASKA, 1986



By: Alan C. Havens

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STATE OF ALASKA  
Steve Cowper, Governor  
ALASKA DEPARTMENT OF FISH AND GAME  
Don W. Collinsworth, Commissioner  
DIVISION OF SPORT FISH  
Norval Netsch, Director



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P.O. Box 3-2000, Juneau, Alaska 99802

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## ABSTRACT

Morphological surveys were performed on seven lakes in the Big Lake drainage in July and August 1986. Data from these surveys were used to construct bathymetric maps of each lake. In addition, biological surveys were conducted on each of the seven lakes. Rainbow trout (*Salmo gairdneri* Richardson) and Dolly Varden char (*Salvelinus malma* Walbaum) were captured in Flat and Mirror Lakes and Lloyd's Pond which are interconnected by short channels at the west end of Big Lake. Rainbow trout, but no char, were captured in Long, Stepan, and Twin Lakes, which drain into Big Lake via Meadow Creek. Gill and fyke nets and minnow traps fished in the seven basins of Big Lake in September and October 1986 captured twelve species of fish including 233 rainbow trout ranging in size from 71 millimeters to 432 millimeters and 48 Dolly Varden char ranging from 178 millimeters to 618 millimeters. Minnow traps fished in Meadow and Fish Creeks in October 1986 captured seven species of fish including 138 rainbow trout. No char were captured.

A stratified random creel survey was conducted at Big Lake for 12 days in December 1986 and 7 days in each January and February 1987. Rainbow trout catch and harvest rates ranged from 0 fish/hour to 0.05 and 0.03 fish/hour, respectively. Catch and harvest rates for char ranged from 0.26 and 0.21 fish/hour, respectively to 0.58 and 0.31 fish/hour, respectively.

Biological and creel data obtained from this study were compared to historical biological and creel data. These comparisons indicate that rainbow trout abundance in the Big Lake drainage has decreased from historical levels whereas char abundance has remained relatively stable.

KEY WORDS: Southcentral Alaska, Matanuska-Susitna Valley, Big Lake, rainbow trout, Dolly Varden char, net sampling, creel census.

## INTRODUCTION

Big Lake is located in the Matanuska-Susitna Valley of Southcentral Alaska (Figure 1). Meadow Creek, Big Lake's principal tributary, drains an extensive watershed that includes over 30 lakes and ponds located north and east of the lake, while a minor drainage enters from the west through Flat and Mirror (Mud) Lakes. Fish Creek, the outlet of Big Lake, flows approximately 23 km into the Knik Arm of northern Cook Inlet.

The large number of private residences and easy public access along the lake have contributed to the growth and popularity of a recreational fishery in Big Lake. Currently, there are 934 lake front lots that currently support in excess of 500 private lake front cabins/residences, two state waysides, a private commercial campground, two boat marinas, and at least seven lounge/restaurant

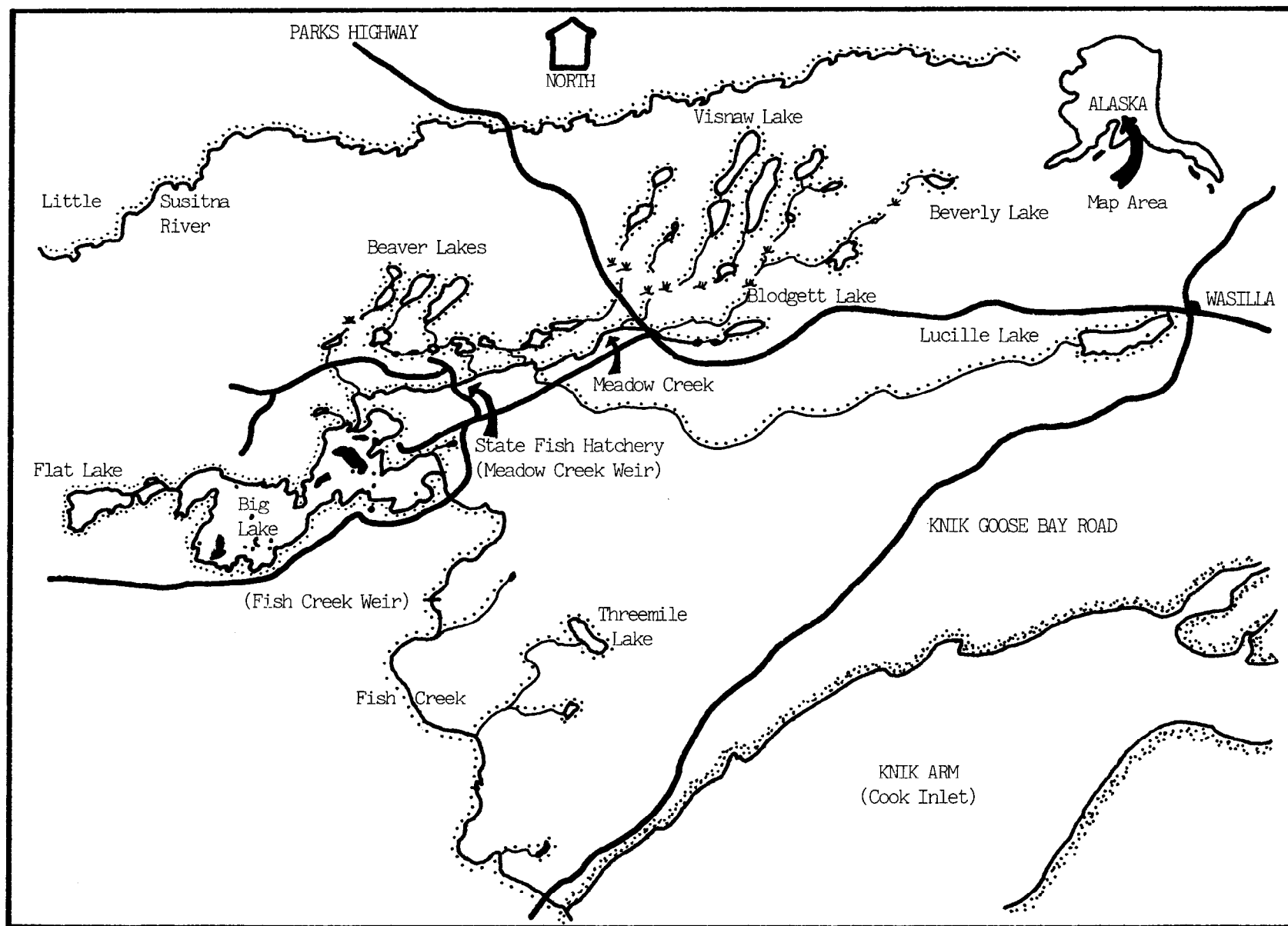


Figure 1. Study area of the Matanuska-Susitna Valley.

establishments including three motel/lodges. During 1952, the U.S. Fish and Wildlife Service conducted fishing pressure studies that indicated 10.9% of all sport fishing on the Alaska mainland south of the Alaska Range occurred on Big Lake (Allin, 1956). During the period 1977 to 1986, annual fishing effort on Big Lake has averaged approximately 13,100 angler-days (Mills 1979-1986 and Mills in press) which represents over 7% of all freshwater fishing effort in the Matanuska-Susitna Valley including anadromous salmon. Big Lake is perhaps the largest producer of non-anadromous Dolly Varden/Arctic char<sup>1</sup> (*Salvelinus* sp.) in Alaska, has the largest ice-fishery for char, and in 1985 had the fifth largest single system harvest of char statewide. Big Lake is second only to the Kenai River for the harvest of native rainbow trout (*Salvelinus gairdneri* Richardson). The lake is also the site of an Alaska Department of Fish and Game (ADF&G) hatchery. In 1986, this hatchery released 15,000,000 sockeye (*Oncorhynchus nerka* Walbaum) fry and 2,355,000 coho (*Oncorhynchus kisutch* Walbaum), salmon fingerling into the Big Lake drainage.

Pronounced reductions in harvest and catch rate for both rainbow trout and char during the period 1983 to 1984 (Table 1 and Figure 2) provided the impetus for this investigation. Although both rainbow trout and char harvest and CPUE have shown some improvement since 1985, the development of management strategies and regulatory measures to achieve optimum sustained recreational yield for these species remains a goal.

A three phase investigation was proposed to achieve this goal: (1) acquire baseline data on Big Lake rainbow trout and char populations and assess angler use patterns; (2) characterize habitats (in Big Lake and its inlets and outlet) of rainbow trout and char spawning areas, rearing areas, and harvest areas; and (3) develop appropriate management strategies through regulatory measures and/or supplemental production.<sup>2</sup> The objective of this report is to present results of the first year of study.

## METHODS

The study design for the Big Lake rainbow trout and char project in 1986-1987 had three major components: (1) map making and historical data review, (2) lake surveys and fish population studies, and (3) creel survey to obtain specific information concerning the sport fishery. The map of the Big Lake drainage system consists of aerial photos purchased from a commercial vendor and is housed at the ADF&G

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<sup>1</sup> Gill raker and pyloric caeca counts indicate that these fish are probably composed of both Dolly Varden (*Salvelinus malma* Richardson), and Arctic char (*Salvelinus alpinus* Richardson). Hereafter in this report, these fish will be referred to as "char".

<sup>2</sup> The Big Lake/Meadow Creek strain rainbow trout brood stock at Ft. Richardson hatchery are providing fish for Alaska's landlocked lake stocking program.

Table 1. Sport effort, harvest, and catch per unit effort (CPUE) for rainbow trout and Dolly Varden/Arctic char, 1977-1986<sup>1</sup>.

Year	Effort (angler- days)	Rainbow Trout		Dolly Varden/ Arctic Char		Composition	
		Harvest	CPUE	Harvest	CPUE	RT	: DV/AC
1977	11,869	3,906	0.329	4953	0.417	44%	: 56%
1978	9,865	4,845	0.491	5433	0.551	47%	: 53%
1979	8,300	2,882	0.347	4227	0.509	41%	: 59%
1980	12,195	5,398	0.443	7585	0.622	42%	: 58%
1981	14,568	9,810	0.673	7741	0.531	56%	: 44%
1982	15,371	9,369	0.610	8793	0.572	52%	: 48%
1983	15,989	4,102	0.257	6126	0.383	40%	: 60%
1984	12,196	4,938	0.405	3866	0.317	56%	: 44%
1985	16,299	6,953	0.427	8096	0.497	46%	: 54%
1986	14,559	5,105	0.351	7406	0.509	41%	: 59%
Average	13,121	5,731	0.433	6,423	0.491	46%	: 54%

<sup>1</sup> Source: Mills (1979-1986) and Mills (in press).

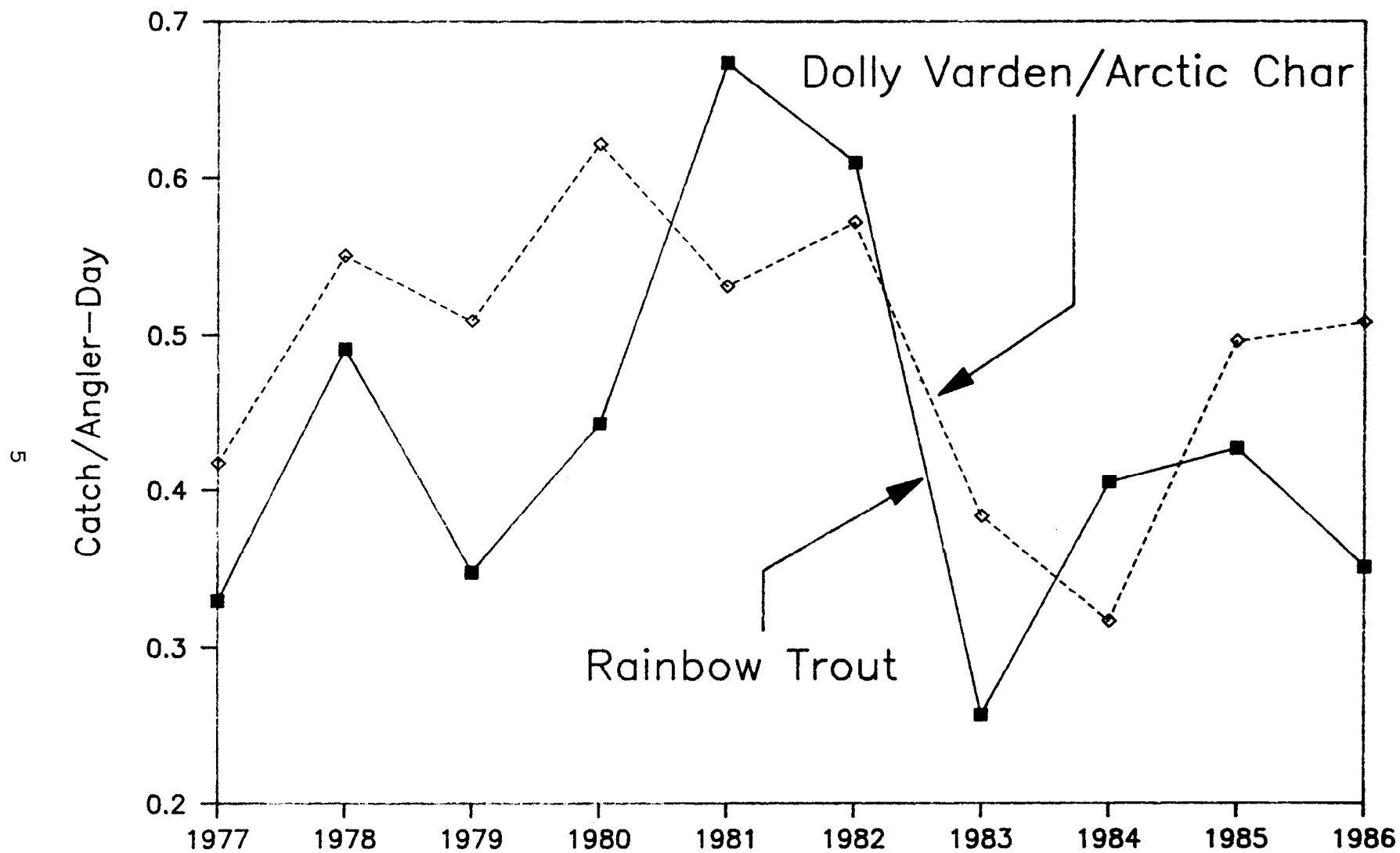


Figure 2. Catch per angler-day in the Big Lake sport fishery for rainbow trout and Dolly Varden/Arctic char, 1977 - 1986.

office in Palmer. Copies of historical data from state and federal records are located at the ADF&G office in Palmer.

### Lake Surveys

Physical, chemical, and biological data were collected from Flat, Mirror (Mud), Stepan, Lazy, Twin, and Long Lakes and Lloyd's Pond (Root Beer Lake) during July and August of 1986 using techniques described by Andrews *et al* (1971). Physical contour mapping of each lake was accomplished using a boat mounted recording fathometer. An aerial photograph (with a given scale or with a scale determined by on-ground point-to-point measurement) was used in conjunction with the chart record to map contour lines in 1.5 m (5.0 ft) increments to the 6.1 m (20.0 ft) depth and 3.1 m (10.0 ft) increments, thereafter. Shoreline length, surface area, volume, and mean depths were calculated from the contoured map using formulae presented in Hutchinson (1975).

A water sample was collected at the 0.9 m (3.0 ft) depth over the deepest portion of each lake by use of a Kemmerer water sampler. Each sample was analyzed for pH, alkalinity, and hardness using a Hach Test Kit Model AL-36DT and for specific conductance using a Cole-Parmer digital conductivity meter.

Fish were collected from each lake by use of gill nets, fyke nets, and minnow traps set overnight. At least one gill net, one fyke net, and five minnow traps were set in all lakes surveyed except Lloyd's Pond which was not gill netted. Gill nets were 36.6 m by 1.8 m (120.0 ft by 6.0 ft) variable mesh monofilament composed of six square mesh sizes: 1.3 cm (0.5 in); 1.6 cm (0.6 in); 1.9 cm (0.8 in); 2.5 cm (1.0 in); 3.8 cm (1.5 in); and 5.1 cm (2.0 in) each in a 6.1 m (20.0 ft) panel. Fyke nets were 2.7 m (9.0 ft) in length by 76.2 cm (30.0 in) in diameter and included two 0.9 m by 6.1 m (3.0 ft by 20.0 ft) wings (two square aluminum frames and six steel or aluminum hoops supported the entrance and body of the fyke net). Internal throats, body, and wings were of 0.5 cm (0.2 in) square mesh knotless nylon. Minnow traps were semi-collapsible and 44.4 cm (17.5 in) length with 0.3 cm (0.1 in) square wire mesh painted green and brown and baited with salmon eggs. All gill netted, fyke netted, and minnow trapped fish were enumerated by capture gear and species.

All rainbow trout and char were measured for fork length to the nearest millimeter and catch rates were computed for each species by gear type.

### Fish Distribution

In September and October 1986, locations in each of the seven basins of Big Lake (Figure 3) were randomly selected for fish sampling. Gill and fyke nets were investigated as to their effectiveness at capturing rainbow trout and char in Big Lake to determine which capture techniques could best delineate the spatial distribution by length and/or age class of these species. In each basin, six potential littoral zone fyke net sampling sites and up to 18

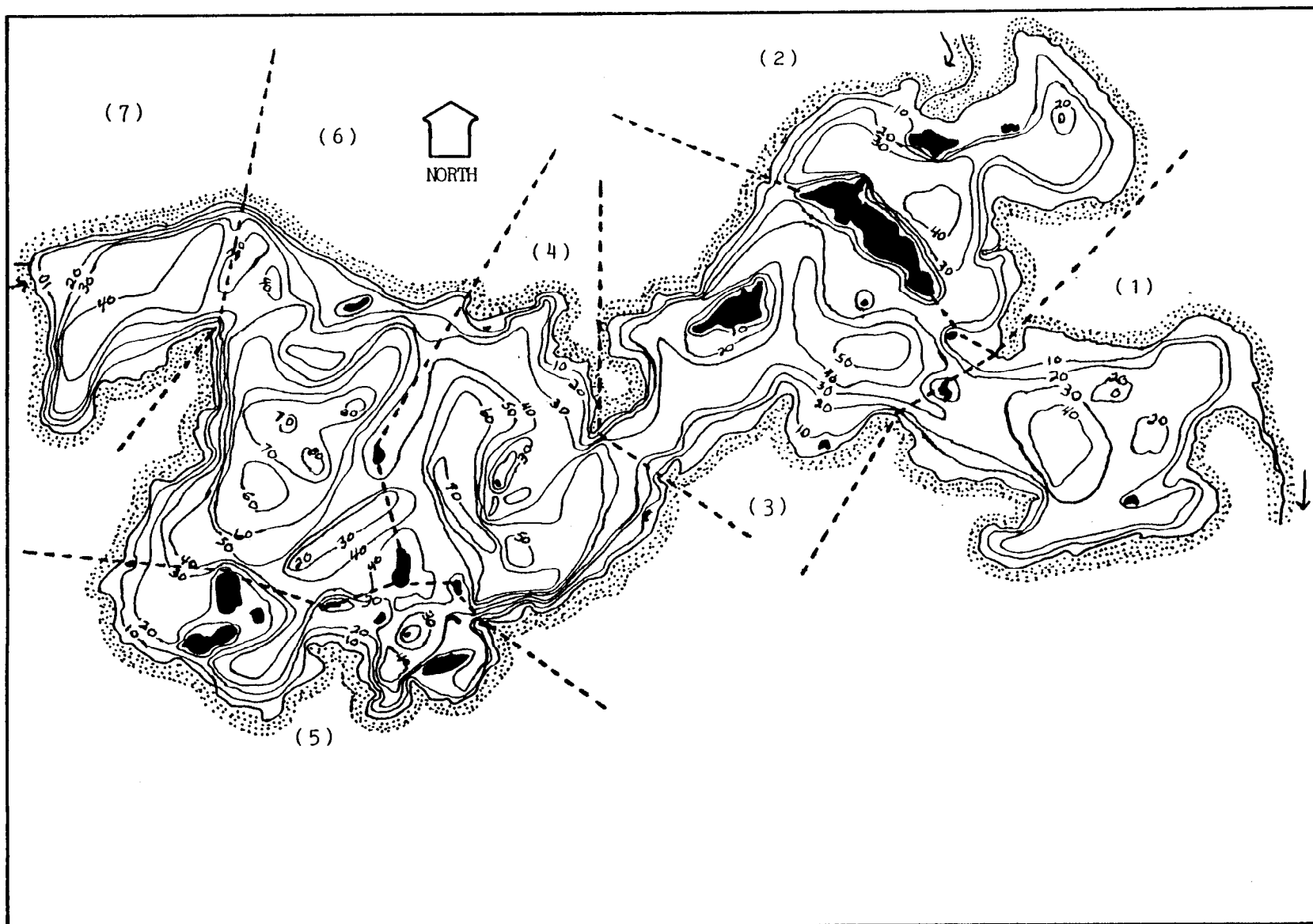


Figure 3. Big Lake contour map partitioned to indicate the seven sampling basins.



potential littoral zone fyke net sampling sites and up to 18 potential gill net sampling sites were identified: six sites from the shoreline; six sites from 6.1 m to 12.2 m (20.0 ft to 40.0 ft) deep or to the bottom; and in basins 4 and 6, six sites from 12.2 m (40.0 ft) to the bottom. Dissolved oxygen profiles were made from water samples collected at each of the seven basins so that nets were not set in waters with less than 2.0 ppm oxygen.

Twice each week during September 1986, three fyke nets and two or three gill nets, depending on basin depth, were set overnight in randomly selected locations in a basin. The basin to be sampled each fishing day was randomly selected without replacement until all basins were selected. Fish captured by gill net were enumerated by species, measured for fork length to the nearest millimeter, and a scale (rainbow trout) or otolith (char) was taken from each rainbow trout/char. All gill netted fish, except adult coho and sockeye salmon, were retained. Fish captured by fyke net were placed in a tub oxygenated with a portable 20 lb oxygen bottle and anesthetized with equal parts of MS-222 and Quinate. Anesthetized fish were enumerated by species and rainbow trout and char were measured for fork length to the nearest millimeter, and released.

#### Sport Fishery

A roving creel survey was conducted on Big Lake from 6 December 1986 through 8 February 1987.<sup>1</sup> The objectives of the survey were to collect catch (fish caught) and harvest (fish kept) rate data for and biological samples from rainbow trout and char harvested by recreational anglers. The survey was not designed to obtain estimates of angler effort or total harvest and therefore only angler interviews were conducted. Interviews were conducted each month during two consecutive weekends and three randomly selected weekdays during the intervening week. Sampling was conducted for 6 hours each day during daylight hours. Twelve days were surveyed in December 1986 and 7 days were surveyed in each January and February 1987.

Interviewed anglers were recorded as to fishing location in one of the seven basins used in the net sampling scheme (Figure 3). Each interviewed angler was asked to provide information concerning: (1) the number of hours fished by basin; (2) the number and species of fish harvested by lake basin; and, (3) the preference to taking rainbow trout, char, other species, or no preference. Also, survey personnel measured harvested rainbow trout and char for fork length to the nearest millimeter and collected scales from all observed rainbow trout and the head of each char (for aging by otolith) that anglers would surrender. Scales and fish heads were labeled and frozen for aging at a later date.

Harvest rate for species *i* was computed by:

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<sup>1</sup> An additional creel survey was conducted from March through October 1987 to survey the fishery throughout the year. Results of the surveys will be presented in a future report.

$$\hat{H}_i = C_i/E,$$

where:

$C_i$  = the total number of fish of species  $i$  kept by anglers interviewed during the run period for that species, and

$E$  = the total number of hours of effort by anglers interviewed during the run period for species  $i$ .

Omitting the finite population correction factor, the variance of  $\hat{H}_i$  was approximated by (Jessen 1978):

$$V(C_i/E) = (C_i/E)^2 [s_C^2/\bar{C}_i^2 + s_E^2/\bar{E}^2 - (2r_i s_C s_E / \bar{C}_i \bar{E})],$$

where:

$\bar{C}_i$  = the mean harvest of species  $i$  by anglers interviewed during the period of species  $i$ ,

$\bar{E}$  = the mean effort (in hours) by anglers interviewed during the run period of species  $i$ ,

$s_C^2$  = the two-stage variance estimate for the mean harvest of species  $i$

$s_E$  = the two-stage variance estimate for the mean effort ( $E$ ), and

$r_i$  = the correlation coefficient between harvest of species  $i$  and effort for individual anglers.

Variances of mean effort and mean harvest were estimated using a two-stage formula (Von Geldern and Tomlinson 1973). Days were considered the first stage sample units and anglers interviewed during a day as the second-stage sample units. Variance was estimated by:

$$V(\bar{X}) = [1 - (d/D)] s_B^2/d + (\sum_{j=1}^D s_j^2/m_j)/dD$$

where:

$\bar{X}$  = mean effort ( $\bar{E}$ ) or mean harvest of species  $i$  ( $\bar{C}_i$ ),

$d$  = number of days sampled during the run period of species  $i$ ,

$D$  = number of days possible to sample during the run period,

$s_B^2$  = the between-day variance for  $\bar{X}$ ,

$s_j^2$  = the sample variance of  $\bar{X}_j$ , the mean effort or harvest of species i by anglers interviewed on day j, and

$m_j$  = the number of anglers interviewed on day j.

Between-day variance ( $s_B^2$ ) was estimated by:

$$s_B^2 = \left[ \sum_{j=1}^D (\bar{X}_j - \bar{X})^2 \right] / (d-1).$$

Catch rate for species i was estimated identically to harvest rate except that mean catch (fish kept plus those released) and its variance were substituted for mean harvest and its variance.

## RESULTS

Between 23 August and 10 October 1986, eight lakes in the Big Lake and Meadow Creek drainages were sampled with minnow traps, fyke nets, and gill nets. Selected areas in Meadow and Fish Creeks were also sampled with minnow traps. Thirteen fish species were captured including rainbow trout; coho salmon; sockeye salmon; round whitefish (*Prosopium cylindraceum* Pallas); burbot (*Lota lota* Linnaeus); longnose sucker (*Catostomus catostomus* Forster); slimy sculpin (*Cottus cognatus* Richardson); prickly sculpin (*Cottus asper* Richardson); threespine stickleback (*Gasterosteus aculeatus* Linnaeus); ninespine stickleback (*Pungitius pungitius* Linnaeus); Arctic lamprey (*Lampetra japonica* Martens); and, both Dolly Varden and Arctic char.

### Lake Surveys

Bathymetric maps are presented in Figure 3 and Appendix Figures 1-7. Physical and water chemistry data are presented in Appendix Tables 1 and 2, respectively.

### Fish Distribution

Stickleback and juvenile coho salmon dominated the catches in all gear types in all lakes whereas rainbow trout and char comprised only minor portions of catches of all gear types in all lakes (Tables 2 and 3). Combined gill net and fyke net catches of rainbow trout, by basin, ranged from 18 fish each in basin's 6 and 7 near the west end of Big Lake to 71 fish in basin 1 which is closest to the Fish Creek outlet. Char catches were small in all cases and ranged from 2 fish

Table 2. Catch and effort by gear type during surveys of Flat, Lazy, Long, Mirror, Stepan, and Twin Lakes, and Lloyd's Pond, 23 July through 5 August 1986.

Lake	Sample Date	Surface Area (ha)	Capture Method <sup>1</sup>	Number of Traps	Number of Hours	Number of Fish Captured							
						Rainbow Trout	Char	Coho Salmon	Sockeye Salmon	Round White fish	Long nose Sucker	Slimy Sculpin <sup>2</sup>	Three spine Stickleback <sup>3</sup>
Flat	07/29/86	119.7	MT	20	520.0	0	0	51	0	0	14	257	156
			FN	2	52.6	0	0	545	0	0	10	0	400
			GN	3	78.0	8	3	27	61	1	7	0	0
			TOTALS:			8	3	623	61	1	31	257	556
Mirror	07/29/86	17.8	MT	9	216.0	0	0	13	0	0	2	99	123
			FN	1	24.5	13	0	76	0	0	31	1	300
			GN	1	24.0	1	2	17	11	0	0	0	0
			TOTALS:			14	2	106	11	0	33	100	423
Lloyd's Pond	07/30/86	3.6	MT	5	100.0	2	0	10	0	0	6	19	46
			FN	1	20.0	0	0	13	0	0	64	2	75
			TOTALS:			2	0	23	0	0	70	21	121
Lazy	07/24/86	9.1	MT	10	210.0	0	0	2	0	0	0	0	342
			FN	1	20.8	0	0	25	0	0	0	0	100
			GN	2	41.5	0	0	34	0	0	0	0	0
			TOTALS:			0	0	61	0	0	0	0	442

(continued)

Table 2. Catch and effort by gear type during surveys of Flat, Lazy, Long, Mirror, Stepan, and Twin Lakes, and Lloyd's Pond, 23 July through 5 August 1986 (continued).

Lake	Sample Date	Surface Area (ha)	Capture Method <sup>1</sup>	Number of Traps	Number of Hours	Number of Fish Captured							
						Rainbow Trout	Char	Coho Salmon	Sockeye Salmon	White fish	Long nose Sucker	Slimy Sculpin <sup>2</sup>	Three spine Stickleback <sup>3</sup>
Long	08/05/86	18.0	MT	12	306.0	0	0	96	0	0	0	0	385
			FN	1	24.8	5	0	211	0	0	9	0	200
			GN	2	52.0	8	0	16	0	0	13	0	0
			TOTALS:			13	0	323	0	0	22	0	585
Stepan	08/25/86	24.2	MT	10	210.0	0	0	233	0	0	51	2	229
			FN	1	20.3	2	0	107	0	0	126	0	100
			GN	1	20.8	6	0	13	0	0	14	0	0
			TOTALS:			8	0	353	0	0	191	2	329
Twin	07/23/86	25.3	MT	12	270.0	2	0	102	0	0	1	0	335
			FN	1	20.5	2	0	0	0	0	12	0	100
			GN	2	47.5	17	0	20	0	0	11	0	0
			TOTALS:			21	0	122	0	0	24	0	435

<sup>1</sup> MT = Minnow Trap

GN = Gillnet

FN = Fyke Net

<sup>2</sup> Slimy sculpin were the majority of cottids captured although a few prickly sculpin were identified.

<sup>3</sup> Threespine stickleback were the majority of stickleback captured although a few ninespine stickleback were identified.

Table 3. Catch and effort by gear type and basin during surveys in Big Lake, September, 1986.

		Number Captured												
Basin	Capture Method <sup>1</sup>	Number Traps	Trap Hours	Rainbow Trout		Coho Salmon <sup>2</sup>		Sockeye Salmon <sup>2</sup>		Burbot	Longnose Sucker	Round Whitefish	Slimy Sculpin <sup>3</sup>	Threespine Stickleback <sup>4</sup>
				Trout	Char	Juvenile	Adult	Juvenile	Adult					
1	FN	3	68.5	67	0	1,610	0	1	5	1	80	0	89	125
	GN	2	47.5	4	3	15	0	1	8	0	19	1	0	0
	Total			71	3	1,625	0	2	13	1	99	1	89	125
2	FN	3	64.8	24	0	1,328	0	13	0	0	67	0	33	
	GN	2	44.8	13	2	39	1	10	3	0	8	1	0	1,500
	Total			37	2	1,367	1	23	3	0	75	1	33	1,500
3	FN	3	67.8	30	0	1,265	0	100	0	0	41	0	65	450
	GN	2	45.8	11	3	43	0	0	18	0	8	8	0	0
	Total			41	3	1,308	0	100	18	0	49	8	65	450
4	FN	3	65.2	19	0	970	0	13	2	0	24	0	60	8,000
	GN	2	45.5	4	14	3	0	4	25	0	11	5	0	0
	Total			23	14	973	0	17	27	0	35	5	60	8,000
5	FN	3	66.8	22	0	1,955	0	4	4	1	27	0	56	1,150
	GN	1	22.7	2	7	29	0	4	40	0	21	2	0	0
	Total			24	7	1,984	0	8	44	1	48	2	56	1,150

(continued)

Table 3. Catch and effort by gear type and basin during surveys in Big Lake, September, 1986 (continued).

Basin	Method <sup>1</sup>	Capture Number Traps	Trap Hours	Number Captured										
				Rainbow Trout		Coho Salmon <sup>2</sup>		Sockeye Salmon <sup>2</sup>		Burbot	Sucker	Round Whitefish	Slimy Sculpin <sup>3</sup>	Threespine Stickleback <sup>4</sup>
				Char	Trout	Juvenile	Adult	Juvenile	Adult					
6	FN	3	68.2	15	0	1,192	0	12	3	0	16	0	66	7,000
	GN	2	46.2	3	7	12	0	14	24	1	22	2	0	0
	Total			18	7	1,204	0	26	27	1	38	2	66	7,000
7	FN	3	68.8	12	0	2,352	0	27	0	0	10	0	50	2,550
	GN	2	49.2	6	12	53	0	11	21	0	14	1	0	0
	Total			18	12	2,405	0	38	21	0	24	1	50	2,550
Total	FN	21		189	0	10,672	0	170	14	2	265	0	419	20,775
	GN	13		43	48	194	1	44	139	1	103	20	0	0
	MT			1	0	0	0	0	0	0	0	0	5,697	0

<sup>1</sup> GN = Gillnet

FN = Fyke Net

MT = Minnow Trap

<sup>2</sup> Numbers of coho salmon and sockeye salmon are presented as juveniles (pre-smolt or landlocked) and adult (anadromous spawners).

<sup>3</sup> Slimy sculpin were the majority of cottids captured although a few prickly sculpin were identified.

<sup>4</sup> Threespine stickleback were the majority of stickleback captured although a few ninespine stickleback were identified.

in basin 2 to 14 fish in basin 4. Mean lengths of captured rainbow trout and char are presented in Tables 4 and 5.

Minnow traps fished in lake waters captured virtually no rainbow trout and no char (Table 6). Although minnow traps fished in Fish and Meadow Creeks were more effective at catching rainbow trout, no char were captured in these sets.

### Sport Fishery

Creel surveys conducted at Big Lake during December 1986 and January and February 1987 showed a progressively declining catch and harvest rate by month for rainbow trout and char (Table 7 and Figure 4). Most of the char and coho salmon harvested in the sport fishery represent a relatively narrow range of lengths (Figure 5). Conversely, the distribution of lengths for rainbow trout harvested by the sport fishery was relatively wide.

Length frequencies for gill net caught rainbow trout and char during September and October were significantly different ( $p = 0.05$ ) from the length compositions of these species in the sport harvest (Figures 6 and 7). However, sample sizes were small and it appears that the gill net sampling for rainbow trout and char during September and October at least provided an approximation of the major length categories of that portion of the population available to the sport fishery. Gill net sampling for coho salmon caught mostly pre-recruits to the fishery (Figure 8) and the length compositions were significantly different ( $p = 0.05$ ).

## DISCUSSION

Sampling conducted during 1986 and historical weir records (Ward 1974), indicate that resident rainbow trout are found throughout the Big Lake drainage.<sup>1</sup> Big Lake drainage char, however, appear to complete their entire life cycle in interconnected Big, Mirror, and Flat Lakes and do not utilize either Fish or Meadow Creeks to any great extent for spawning or rearing.

### Comparisons with Historical Data<sup>2</sup>

Catch rates from test gill nets declined from 0.77 and 0.75 rainbow trout/hour in 1961 (Andrews 1962) and 1972 (Ward 1974), respectively, to 0.35 fish/hour in 1986 (Table 8 and Figure 9). Although it is not possible to compute the precision of the historical estimates, the 95% confidence limits of the 1986 data do not encompass the historical point estimates and thus it is likely that the 1986 estimate is significantly lower than the historical estimates. Char

1 There is no indication that steelhead are present in the Big Lake drainage.

2 Comparisons between historical and current year data are presented. The level of detail with which these data were recorded do not allow for rigorous comparisons.



Table 4. Summary of length (mm) and CPUE data for rainbow trout (RT) and char (CHAR) captured during surveys of Mirror, Stepan and Twin Lakes, and Lloyd's Pond, 23 July through 5 August, 1986.

Lake	Sample Date	Species	Capture Method <sup>1</sup>	Number Caught <sup>2</sup>	Catch/ Net Hour	Length		
						Mean	Std Err	Range
Flat	07/29/86	RT	GN	8	0.10	252	27.2	163 - 408
		CHAR	GN	3	0.04	455	22.4	410 - 480
Mirror	07/29/86	RT	FN	13	0.53	175	22.7	92 - 385
			GN	1	0.04	160		
		CHAR	GN	2	0.08	488	7.5	480 - 495
Lloyd's Pond	07/30/86	RT	MT	2	0.02	103	2.5	100 - 105
Long	08/05/86	RT	FN	5	0.20	115	17.3	78 - 175
			GN	8	0.15	304	38.2	106 - 498
Stepan	08/05/86	RT	FN	2	0.10	178	2.5	175 - 180
			GN	6	0.29	354	34.6	236 - 441
Twin	07/23/86	RT	MT	2	0.01	89	8.5	80 - 97
			FN	2	0.10	235	20	215 - 255
			GN	17	0.36	283	20.1	120 - 420

<sup>1</sup> MT = Minnow Trap

GN = Gillnet

FN = Fyke Net

<sup>2</sup> All fish were measured.

Table 5. Summary of length (mm) and CPUE data by basin for rainbow trout and char  
September, 1986.

Basin	Species	Capture Method <sup>1</sup>	Number <sup>2</sup> Caught	Catch/ Net Hour	Number Measured	Length		
						Mean	Std Err	Range
1	Rainbow Trout	FN	67	0.98	67	146	5.9	82 - 325
		GN	4	0.08	4	248	38.0	200 - 361
	Char	FN	0		0			
		GN	3	0.06	1	530		
2	Rainbow Trout	FN	24	0.37	24	153	14.7	95 - 432
		GN	13	0.29	13	236	23.5	112 - 459
	Char	FN	0		0			
		GN	2	0.04	2	234	43.5	190 - 277
3	Rainbow Trout	FN	30	0.44	30	142	10.8	71 - 362
		GN	11	0.24	11	245	29.0	141 - 398
	Char	FN	0		0			
		GN	3	0.07	3	193	1.5	190 - 195
4	Rainbow Trout	FN	19	0.29	19	191	17.7	83 - 350
		GN	0		4	283	68.5	140 - 407
	Char	FN	0		0			
		GN	14	0.31	14	296	29.5	178 - 486
5	Rainbow Trout	FN	22	0.33	22	138	12.8	72 - 276
		GN	0		2	286	99.0	187 - 385
	Char	FN	0		0			
		GN	5	0.22	7	431	42.8	213 - 541
6	Rainbow Trout	FN	15	0.22	15	165	14.4	88 - 280
		GN	0		3	302	68.1	219 - 437
	Char	FN	0		0			
		GN	6	0.13	7	374	46.9	211 - 490
7	Rainbow Trout	FN	12	0.17	12	185	21.3	112 - 334
		GN	6	0.12	6	389	28.9	272 - 440
	Char	FN	0		0			
		GN	12	0.24	12	376	40.1	210 - 618
Total	Rainbow Trout	FN	189	0.40	189	154	4.5	71 - 432
		GN	34	0.11	43	272	16.0	12 - 459
	Char	FN	0		0			
		GN	45	0.15	46	345	19.4	178 - 618

<sup>1</sup> FN = Fyke net  
GN = Gillnet

<sup>2</sup> One gill net each in basin's 4, 5 and 6 was twisted by adult sockeye salmon so fish captured were not included in catch per net hour data.

Table 6. Minnow trap catches in Big, Flat and Mirror Lakes, Lloyd's Pond and Fish and Meadow Creeks, 29 September through 8 October, 1986.

Area	Number of Traps	Number of Hours	Number Captured								
			Rainbow Trout		Coho Salmon		Sockeye		Slimy Sculpin <sup>1</sup>	Threespine Stickleback <sup>2</sup>	Arctic Lamprey
			Number	CPUE	Number	CPUE	Salmon	Char			
Big Lake (south shore)	77	1,733.0	1	0.001	1,417	0.820	0	0	2,408	1,931	0
Big Lake (north shore)	70	1,487.5	0		1,890	1.270	0	0	1,463	1,411	0
Big Lake (islands)	51	1,121.8	0		1,006	0.900	0	0	1,826	1,008	0
Flat and Mirror Lakes and Lloyd's Pond	50	1,064.8	2	0.002	1,051	0.990	0	0	1,237	976	0
Fish Creek	20	514.2	59	0.115	721	1.400	0	0	69	391	3
Meadow Creek	20	440.2	79	0.179	529	1.200	0	0	79	81	12
Total	288	6,361.50	141	0.0222	6,614	1.04	0	0	7,082	5,798	15

<sup>1</sup> Slimy sculpin were the majority of cottids captured although a few prickly sculpin were identified.

<sup>2</sup> Threespine stickleback were the majority of stickleback captured although a few ninespine stickleback were identified.

Table 7. Sport catch and harvest rates for rainbow trout, char, and coho salmon, Big Lake, 1986-1987.

Sample Period	N <sup>1</sup>	n <sup>2</sup>	Anglers Interviewed	Rainbow Trout				Char				Coho Salmon			
				Catch Rate	S.E. <sup>3</sup>	Harvest Rate	S.E.	Catch Rate	S.E.	Harvest Rate	S.E.	Catch Rate	S.E.	Harvest Rate	S.E.
1 <sup>4</sup>	16	12	195	0.048	0.015	0.022	0.006	0.581	0.093	0.305	0.055	0.246	0.039	0.067	0.022
2 <sup>5</sup>	9	6	124	0.035	0.012	0.028	0.010	0.418	0.089	0.244	0.058	0.220	0.073	0.119	0.042
3 <sup>6</sup>	9	7	237	0.000		0.000		0.259	0.033	0.207	0.027	0.087	0.019	0.067	0.016

<sup>1</sup> N = Number of days possible.

<sup>2</sup> n = Number of days sampled.

<sup>3</sup> S.E. = Standard error.

<sup>4</sup> Sample period from 12/06/86 through 12/21/86.

<sup>5</sup> Sample period from 01/03/87 through 01/11/87.

<sup>6</sup> Sample period from 01/31/87 through 02/08/87.

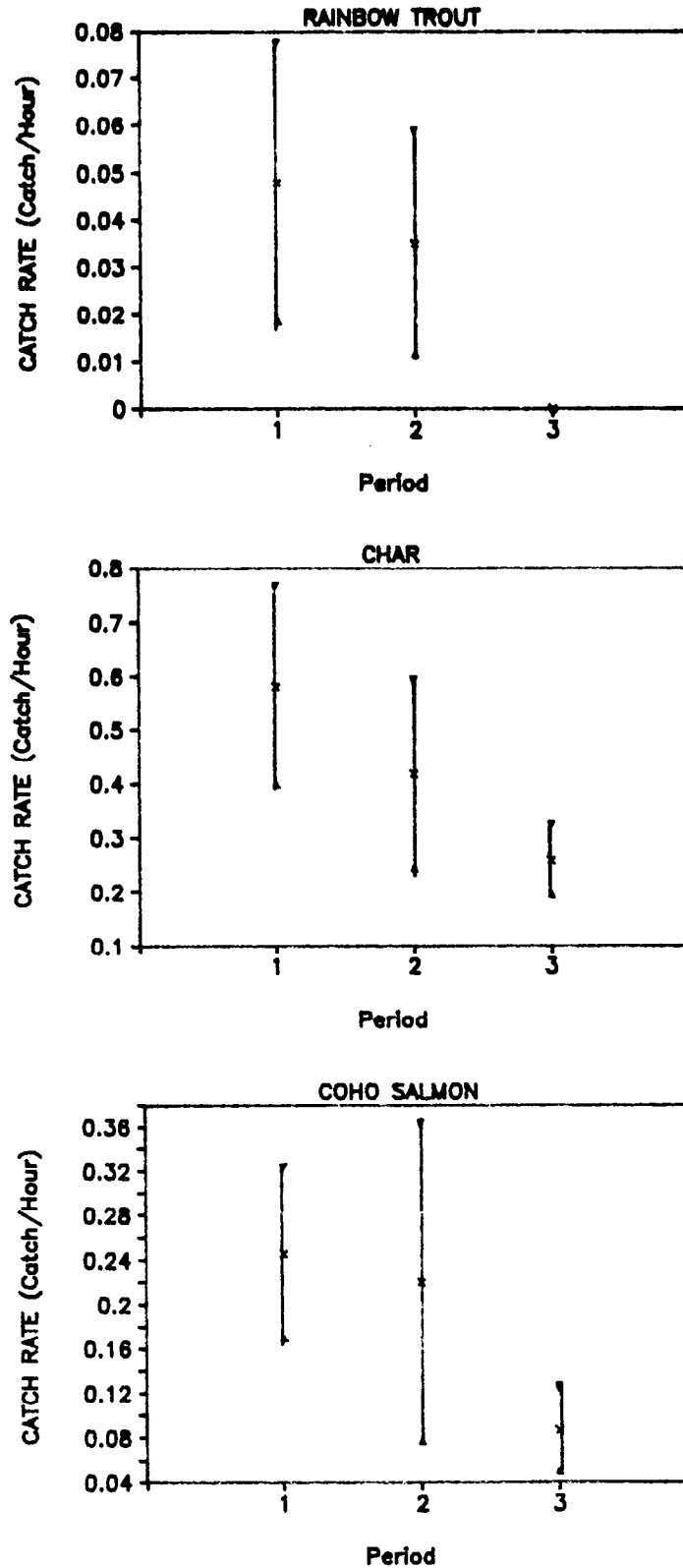


Figure 4. Sport catch rates during the winter sport fishery by species and sample period, Big Lake, 1986 - 1987. Sample periods are: (1) 12/16 - 12/21; (2) 1/3 - 1/11; and, (3) 1/31 - 2/8.

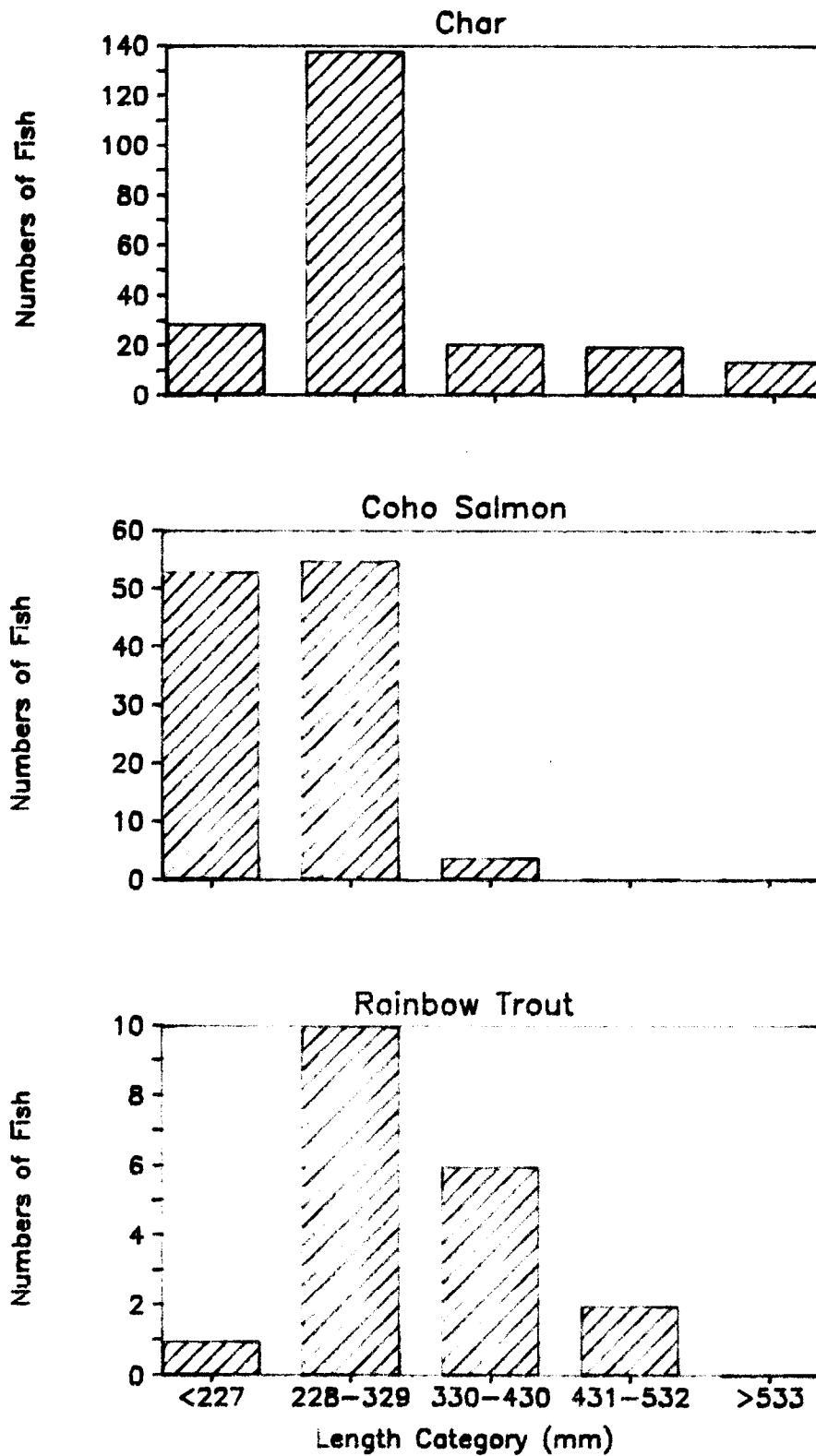


Figure 5. Length frequencies of rainbow trout, char, and coho salmon from the winter sport fishery, Big Lake, 1986-1987.

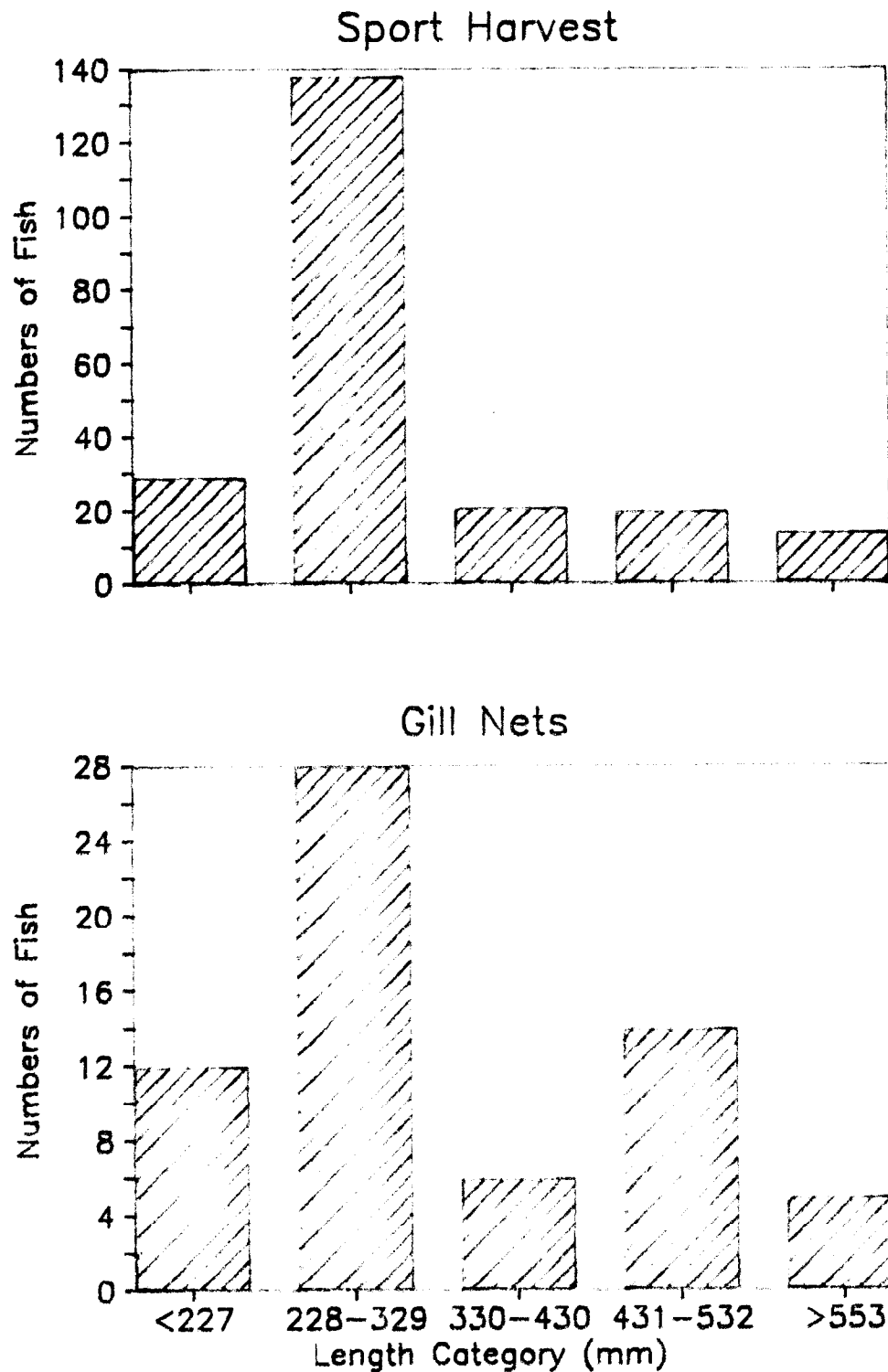


Figure 6. Comparison of length distributions for char captured in gill nets during September and October, 1986 and sport caught during December, 1986 and January and February, 1987.

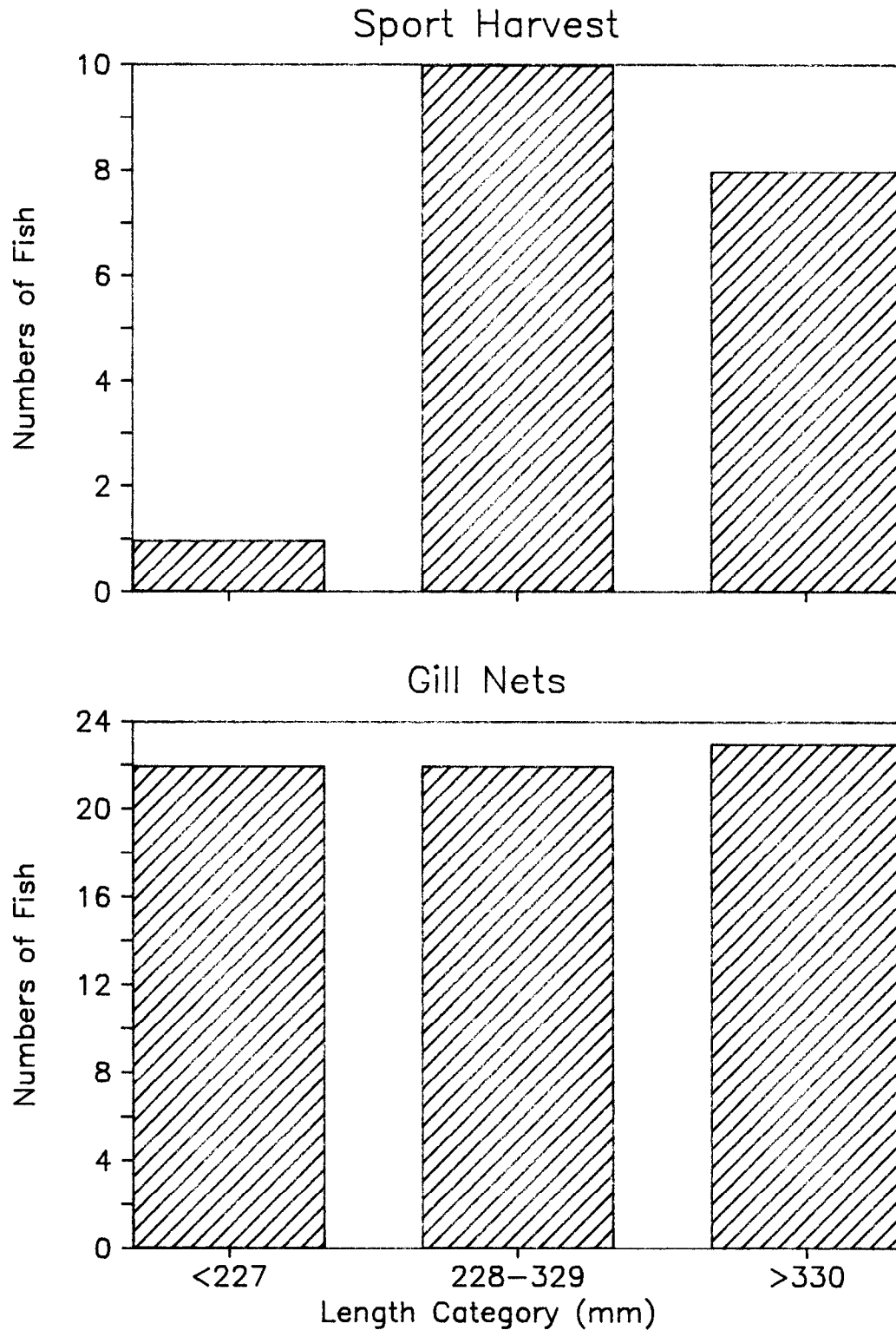


Figure 7. Comparison of length distributions for rainbow trout captured in gill nets during September and October, 1986 and sport caught during December, 1986 and January and February, 1987.



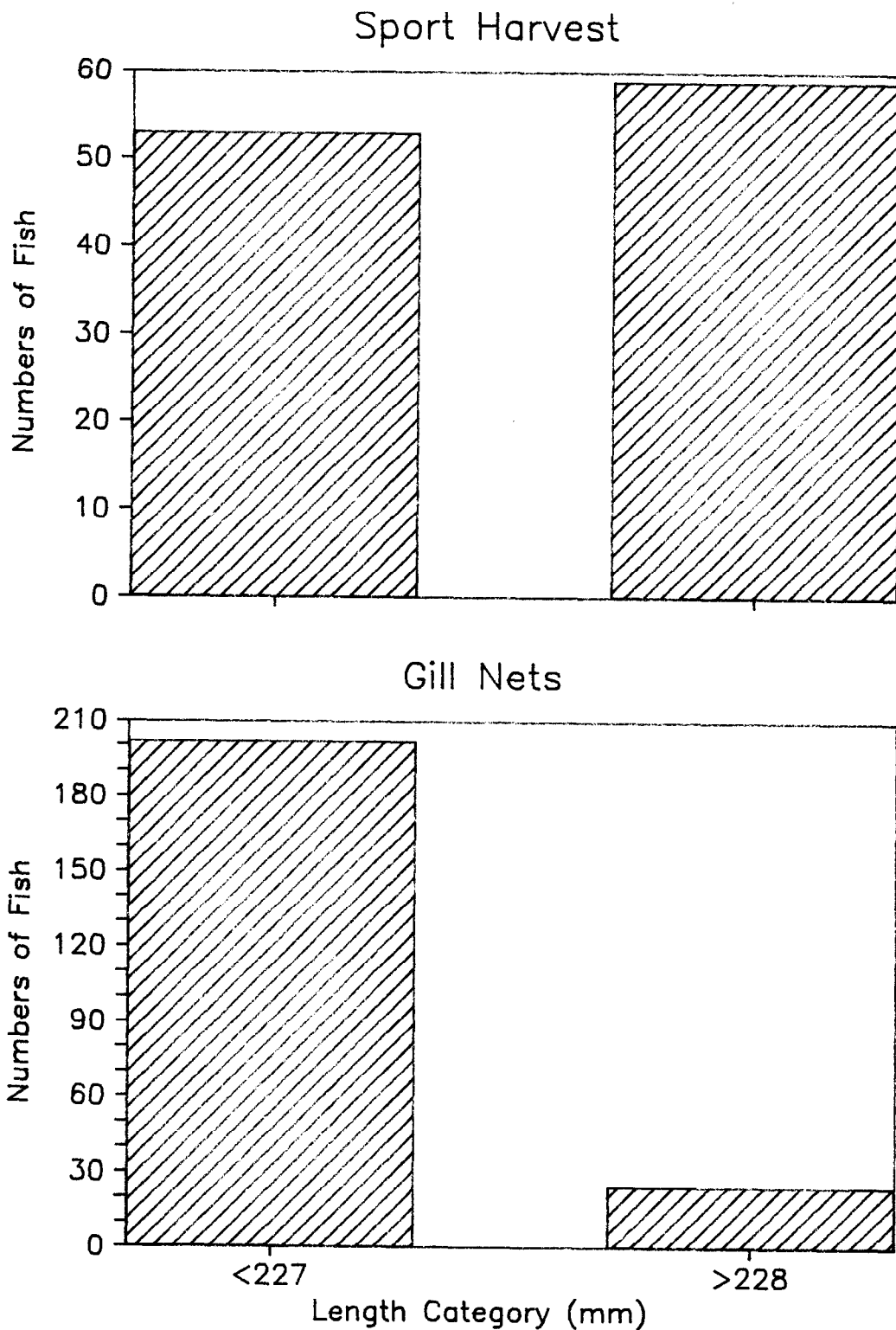


Figure 8. Comparison of length distributions for coho salmon captured in gill nets during September and October, 1986 and sport caught during December, 1986 and January and February, 1987.

Table 8. Mean length (mm), CPUE (catch per hour), and catch composition for rainbow trout captured by gill nets in October 1961, 1972 and 1986.

Sample Date	Species	Number Caught	Length			CPUE		Catch Composition
			Mean	Std Err <sup>1</sup>	Range	Mean	Std Err <sup>1</sup>	
10/12/61	Rainbow Trout	58	272		150 - 437	0.77		69%
	Char	26	358		203 - 511	0.35		31%
10/12/72	Rainbow Trout	18	269		103 - 432	0.75		69%
	Char	8	277		240 - 309	0.33		31%
10/10/86	Rainbow Trout	24	268	23.2	133 - 442	0.35	0.19	56%
	Char	19	224	13.8	186 - 441	0.28	0.17	44%

<sup>1</sup> Original data were not available for 1961 and 1972 gill netting.

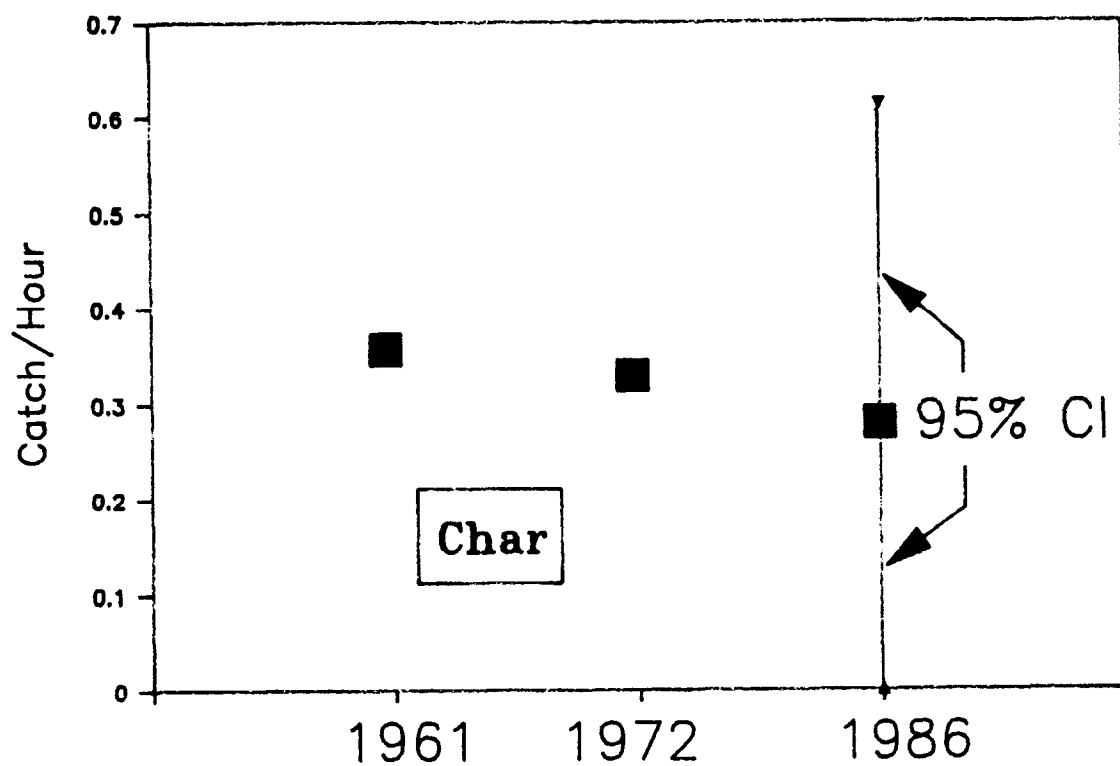
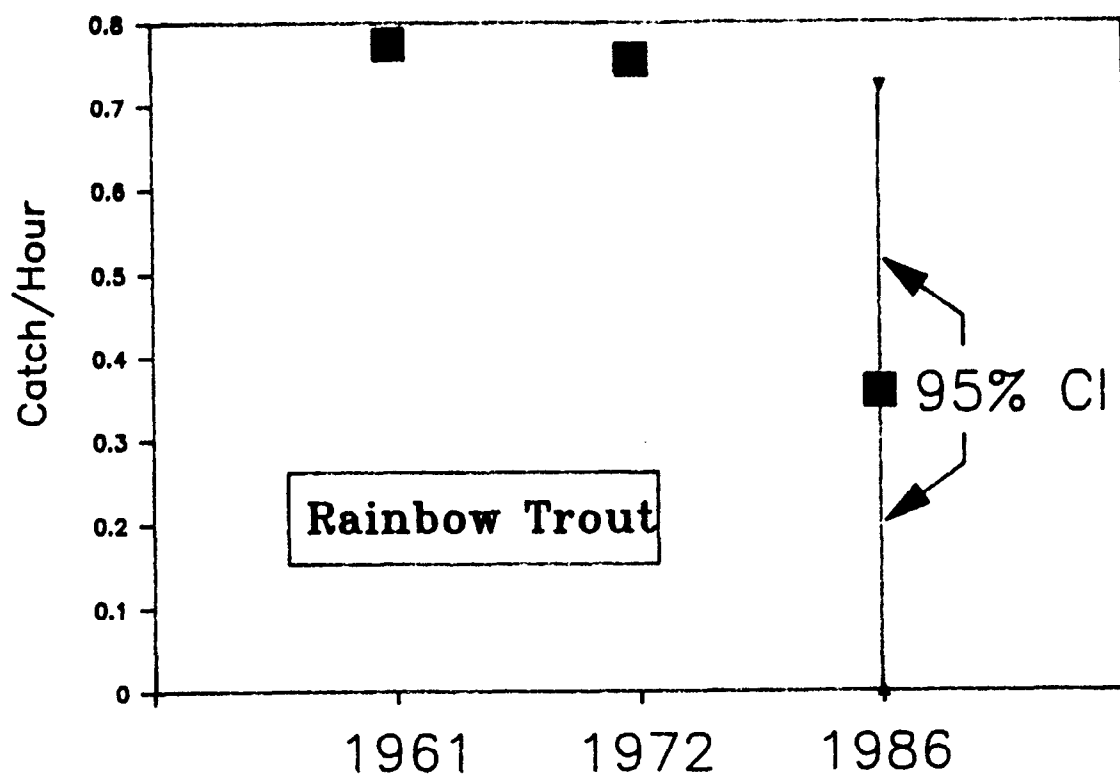


Figure 9. Comparative CPUE (catch/hour) from test gill nets, Big Lake.

catch rates also showed a decline from 0.35 and 0.33 fish/hour in 1961 and 1972, respectively, to 0.28 fish/hour in 1986. However, the historical estimates are encompassed within the 95% confidence limits of the 1986 data thereby making it unlikely that there was a significant decline.

Minnow trap catch data shows a similar decline in rainbow trout abundance (Table 9 and Figure 10). In all cases, historical estimates of catch rates were not encompassed within the 95% confidence limits of the 1986 data thus making it likely that the 1986 estimates are significantly lower than the historical estimates. Minnow traps did not prove effective in capturing char in any of the samples.

Rainbow trout harvest rates from the winter sport fishery also showed a similar decline from historical levels (Figure 11). Comparisons with historical data are difficult since catch rates vary significantly over time (see Figure 4); nevertheless, all historical point estimates of harvest rate are greater than any of the point estimates measured during the 1986-1987 winter fishery. Harvest rates for char as measured during 1986-1987 were less than those measured during 1955 and 1960, but similar to the 1966 estimate.

Length compositions of the 1986-1987 sport harvest of rainbow trout and char were significantly different ( $p = 0.05$ ) from those of the 1960 sport harvests (Figures 12 and 13). For rainbow trout, the most recent harvest was comprised of a higher fraction of larger fish than the 1960 harvest. Differences in the length composition of the char harvests were subtle.

In total, these comparisons point towards a precipitous decline in abundance of rainbow trout. Two measures of adult rainbow trout catch rates, test gill nets, and sport harvest during 1986-1987 were substantially less than comparable historical estimates. Likewise, all measures of juvenile rainbow trout abundance (minnow traps) during 1986 were substantially less than comparable historical estimates. In contrast, there is little evidence that char abundance has declined substantially from historical levels.

#### Recommendations

The Big Lake creel survey should be continued through the entire 1987 open-water period. Harvest estimates reported by Mills (see Table 1) indicate similar catch compositions of rainbow trout and char on an annual basis. Conversely, creel survey results for 1986-1987 show that the harvest was comprised primarily of char (95%). It seems likely that the seasonal fisheries target on different species. This information is necessary to formulate meaningful regulatory measures.

Big Lake rainbow trout should be enhanced through stocking. Logistically, this is fairly simple since Big Lake rainbow trout are already being used as a brood source. Stocking of marked catchable

Table 9. Comparison between 1977 and 1986 minnow trap catch data for index areas in Meadow and Fish creeks within the Big Lake drainage.

Index Area	Sample Date	Number of Traps	Total Trap Hours	Coho Salmon			Rainbow Trout			Composition SS : RT
				Number	Fish/ Hour	Std Err <sup>1</sup>	Number	Fish/ Hour	Std Err <sup>1</sup>	
Fish Creek	10/05/77	20	433.0	878	2.03		385	0.89		70% : 30%
	10/08/86	22	514.2	721	1.39	0.176	59	0.12	0.036	92% : 8%
Meadow Creek	08/23/77	20	267.0	261	0.98		171	0.64		60% : 40%
	08/27/86	20	487.0	646	1.31	0.156	25	0.05	0.012	96% : 4%
	10/04/77	20	477.0	326	0.68		618	1.30		35% : 65%
	10/07/86	20	440.2	529	1.20	0.204	79	0.18	0.043	87% : 13%

<sup>1</sup> Raw data not available for 1977 minnow trapping.

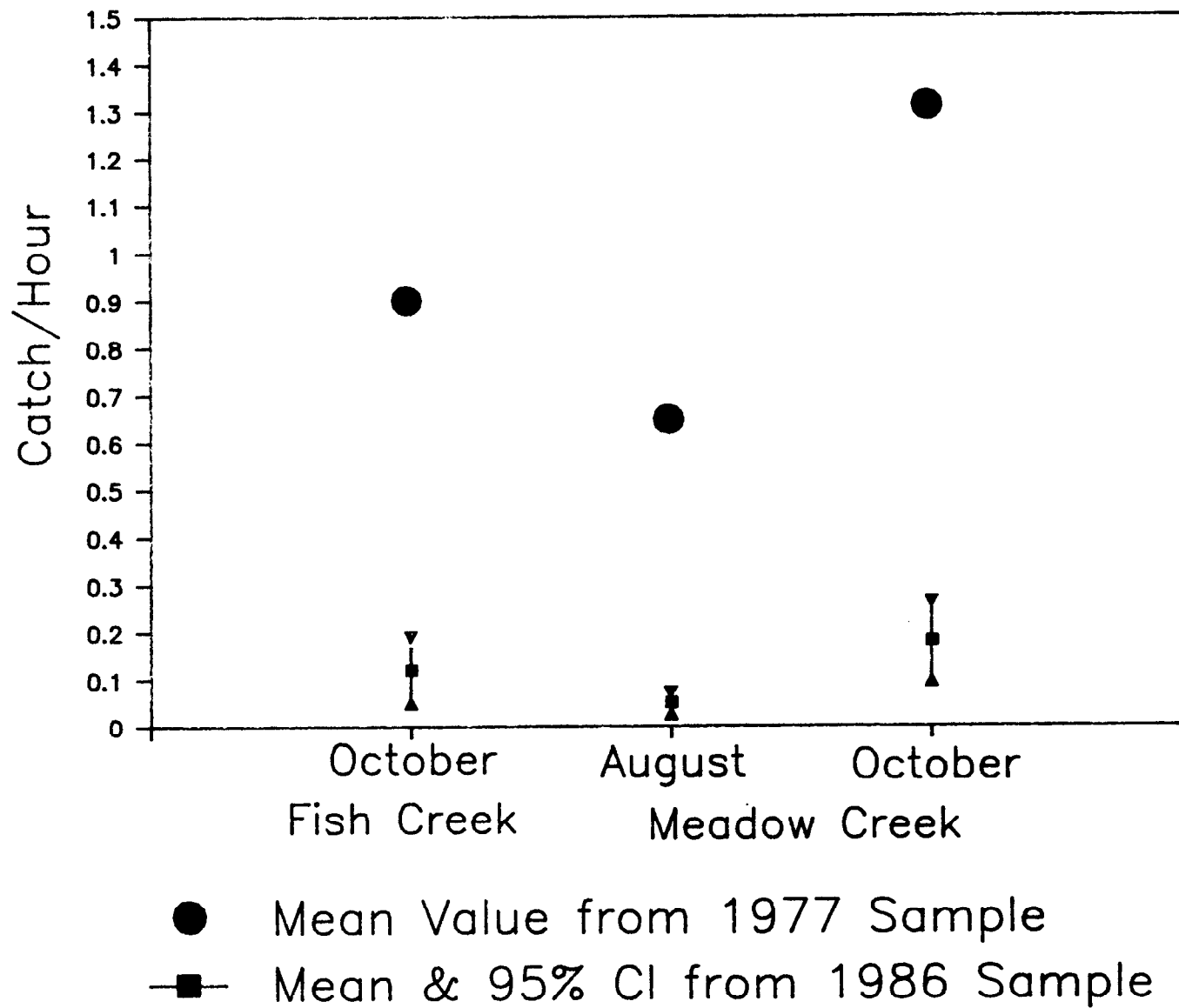


Figure 10. Comparative CPUE (catch/hour) for rainbow trout from minnow traps fished in Fish and Meadow Creeks, 1977 and 1986.

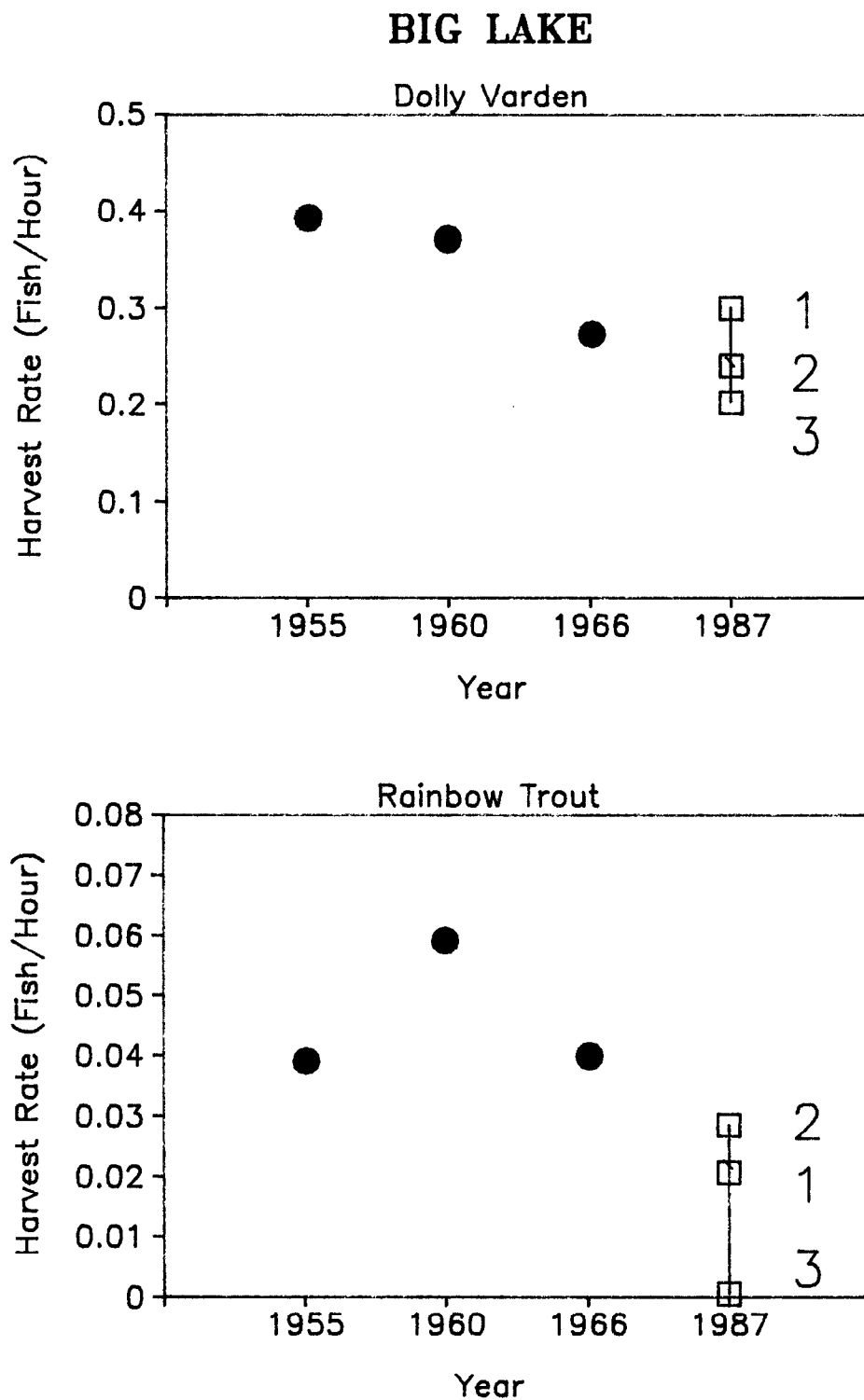


Figure 11. Comparative harvest rates from the winter sport fishery, Big Lake. During 1987, harvest rates were estimated during three time frames: (1) December 1986; (2) January 1987; (3) February 1987.

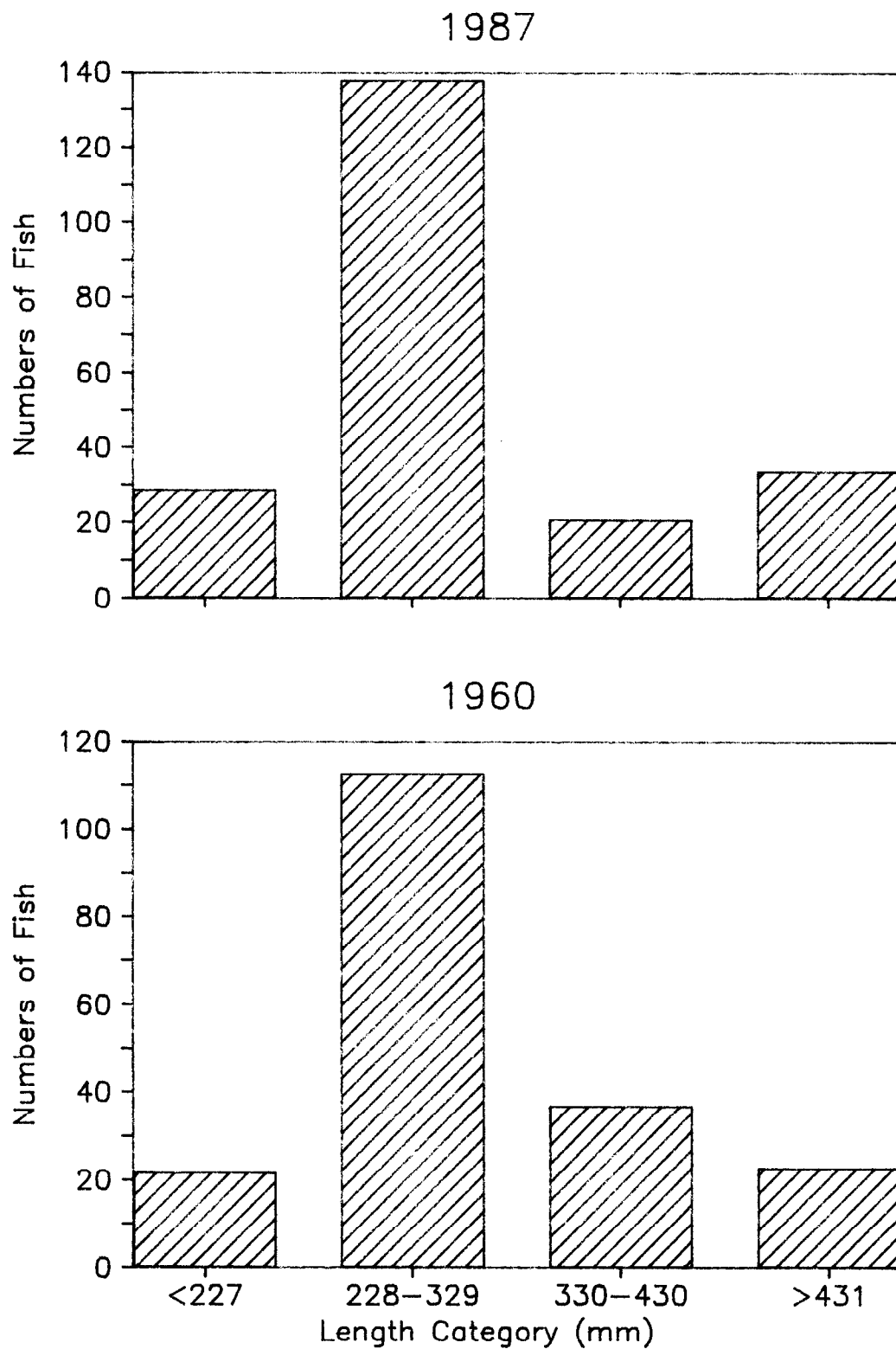


Figure 12. Length frequencies for char sampled from the winter sport fisheries, 1960 and 1986-1987.



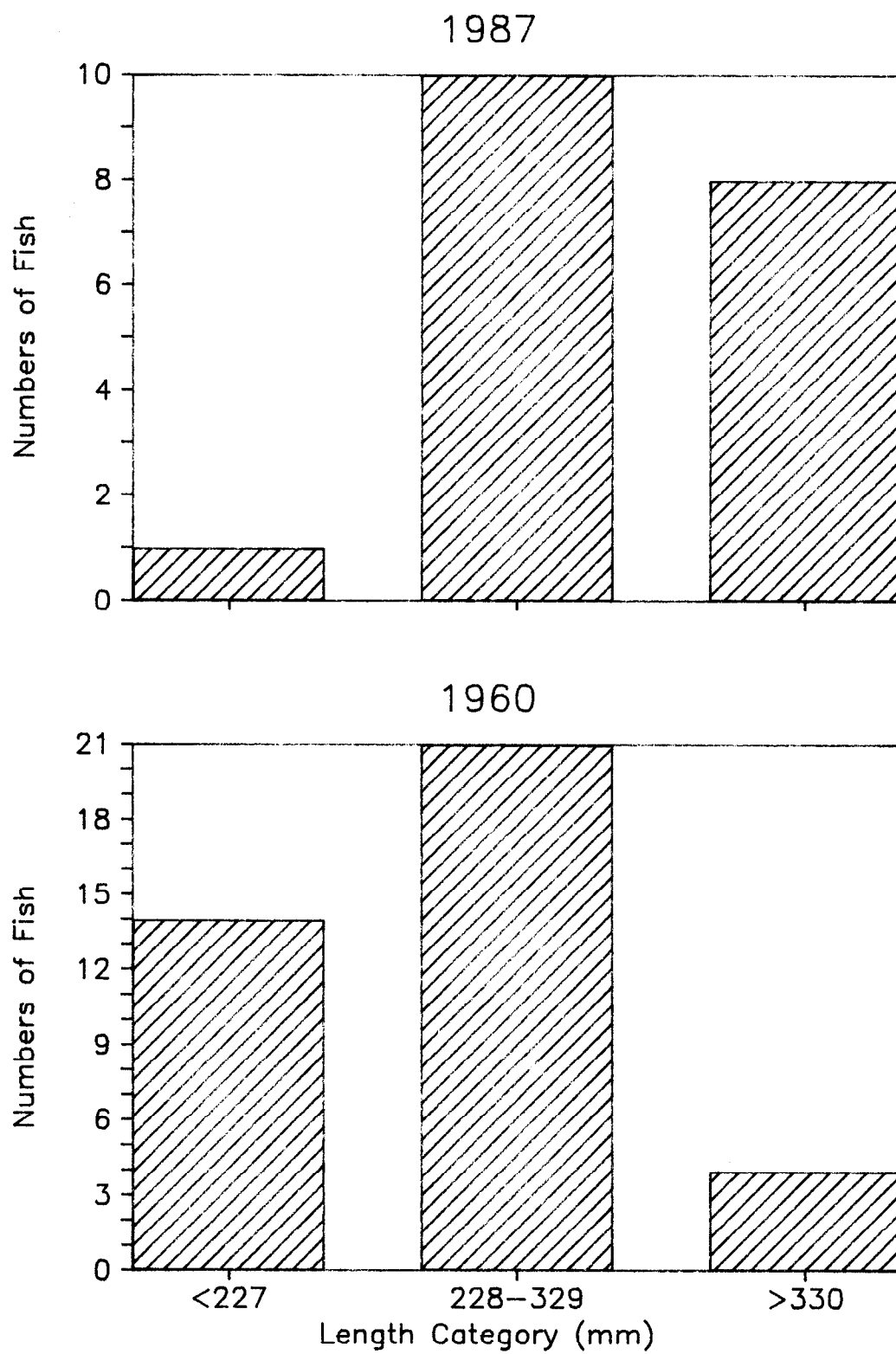


Figure 13. Length frequencies of rainbow trout sampled from the winter sport fisheries, 1960 and 1986-1987.

rainbow trout could also provide an opportunity to measure the abundance of adult rainbow trout.

#### ACKNOWLEDGEMENTS

To Larry Engel, Palmer Sport Fish Area Management Biologist, for his many suggestions regarding sampling schemes and data interpretation; Terrence Bradley and Craig Baer for their innovation and persistence in sample collection and their timely data summation during the fish population sampling and creel census, respectively; and Mike Duxbury, Stan Walker, and Bob Begich for their invaluable field assistance.

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## APPENDIX TABLES

Appendix Table 1. Physical data collected during surveys of Flat, Lazy, Long, Mirror, Stepan, Big, and Twin Lakes and Lloyd's Pond, 21 July through 4 August 1986.

Lake	Sample Date	Location		Surface	Maximum	Mean	Shoreline	Surface
		Latitude,	Longitude	Area (ha)	Depth (m)	Depth (m)	Distance (km)	Elevation (m)
Flat	07/29/86	61 31'50"N,	150 00'30"W	119.7	13.4	5.6	8.2	43.2
Mirror	07/30/86	61 32'05"N,	149 58'45"W	17.8	10.4	4.6	2.3	43.3
Lloyd's Pond	07/30/86	61 35'15"N,	149 58'40"W	3.6	9.1	4.7	0.8	43.3
Lazy	07/24/86	61 34'20"N,	149 48'20"W	9.1	4.0	1.5	1.9	51.8
Long	08/04/86	61 34'40"N,	149 46'00"W	18.0	5.2	2.7	2.3	57.9
Stepan	07/21/86	61 34'20"N,	149 49'00"W	24.2	5.2	2.7	2.9	51.8
Twin	07/21/86	61 34'25"N,	149 46'40"W	25.3	6.1	2.7	3.7	56.3
Big	1974	61 31'145"N,	149 59'00"W	1,009.7	27.1	9.1	41.8	43.2

Appendix Table 2. Water chemistry data collected during surveys of Flat, Lazy, Long, Mirror, Stepan and Twin Lakes, and Lloyd's Pond, 1986.

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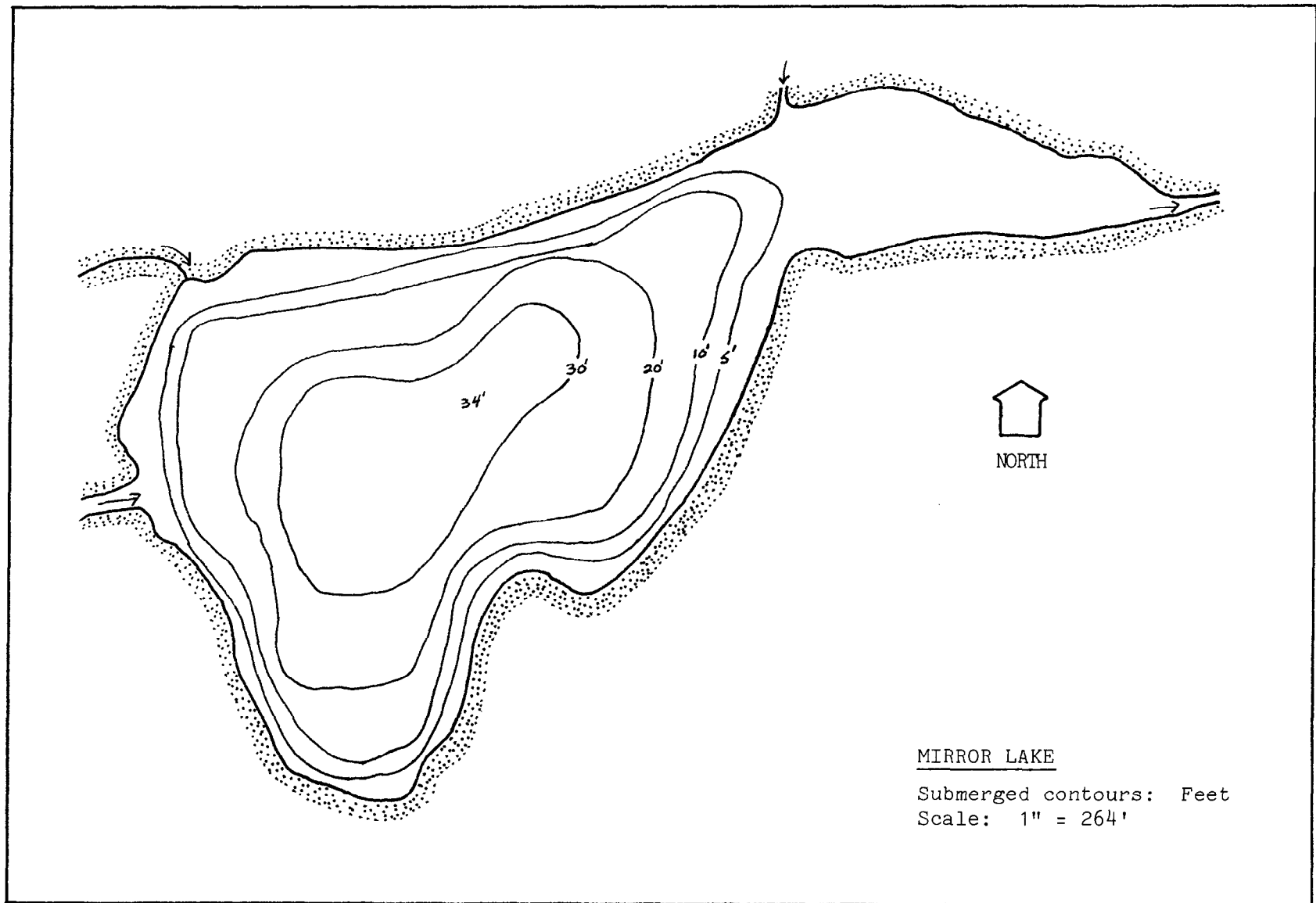
Lake	Sample		Alkalinity (mg/l)	Conductivity (micromhos)	Hardness (mg/l)	pH (units)
	Sample Date	Depth (m)				
Flat	07/29/86	1	48	74	57	7.4
Mirror	07/30/86	1	46	117	50	7.7
Lloyd's Pond	07/30/86	1	38	112	51	7.4
Lazy	07/23/86	1	29	69	44	7.1
Long	08/04/86	1	34	96	39	7.4
Stepan	07/21/86	1	45	110	46	7.5
Twin	07/22/86	1	38	97	52	7.6

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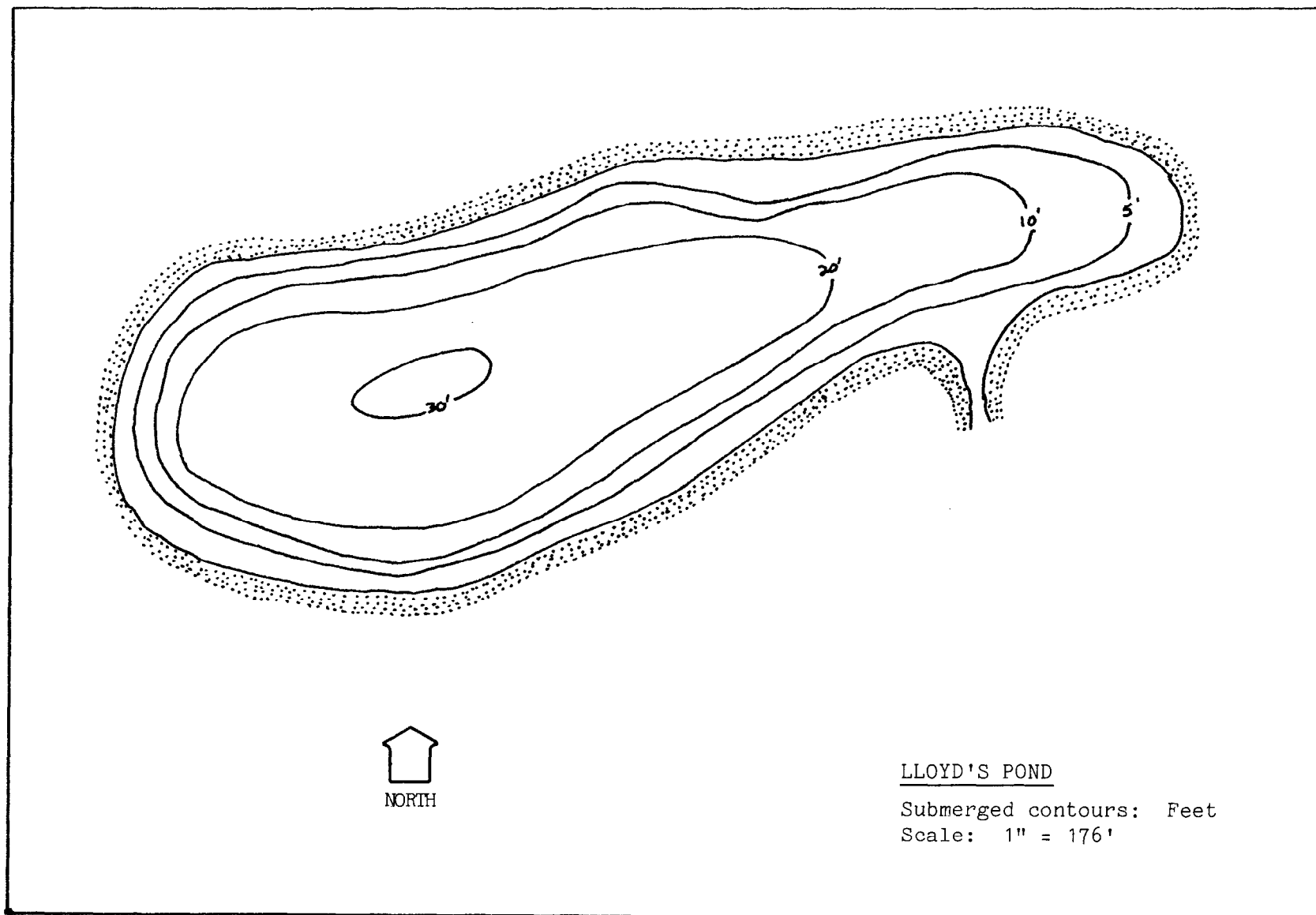


## APPENDIX FIGURES

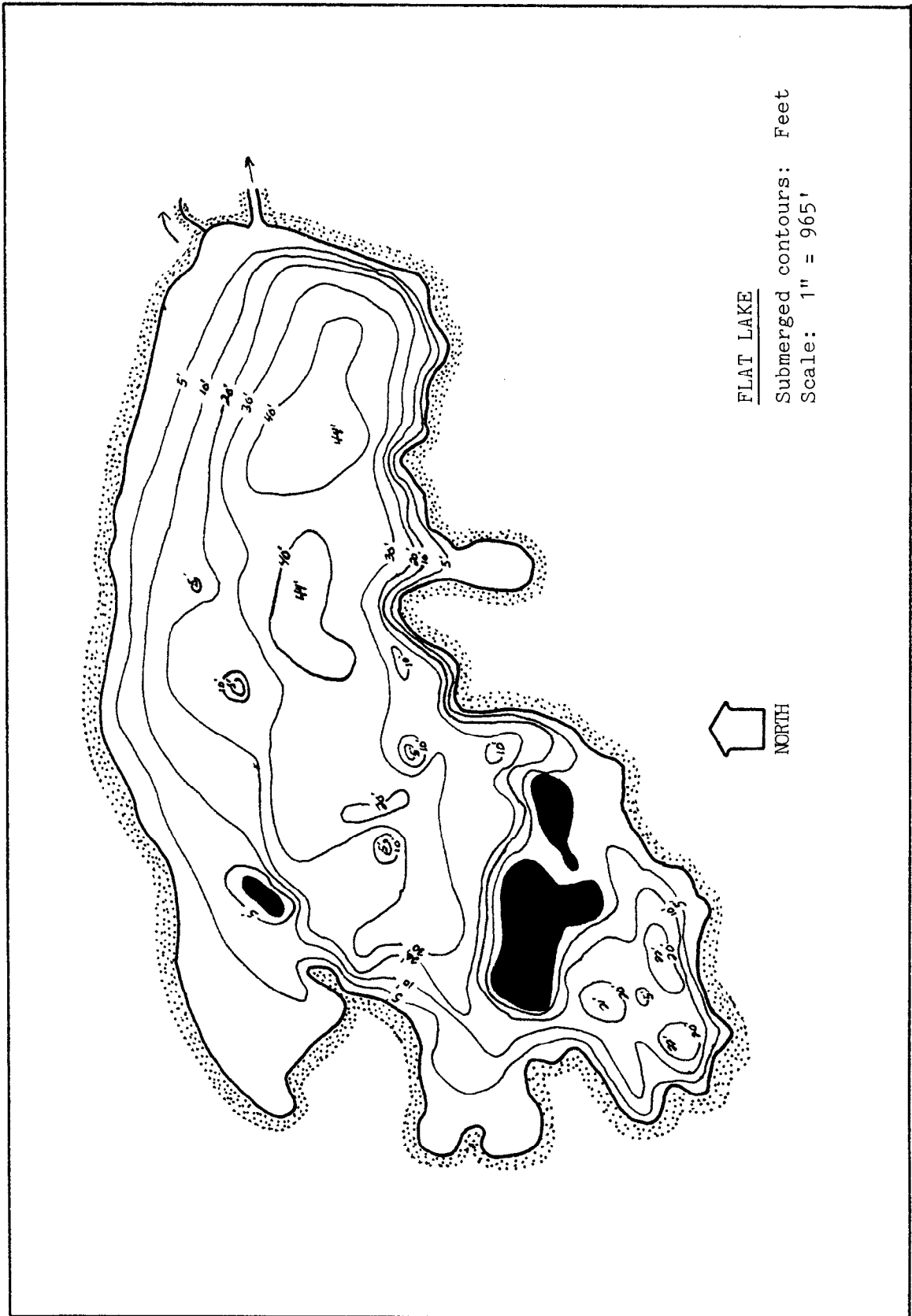




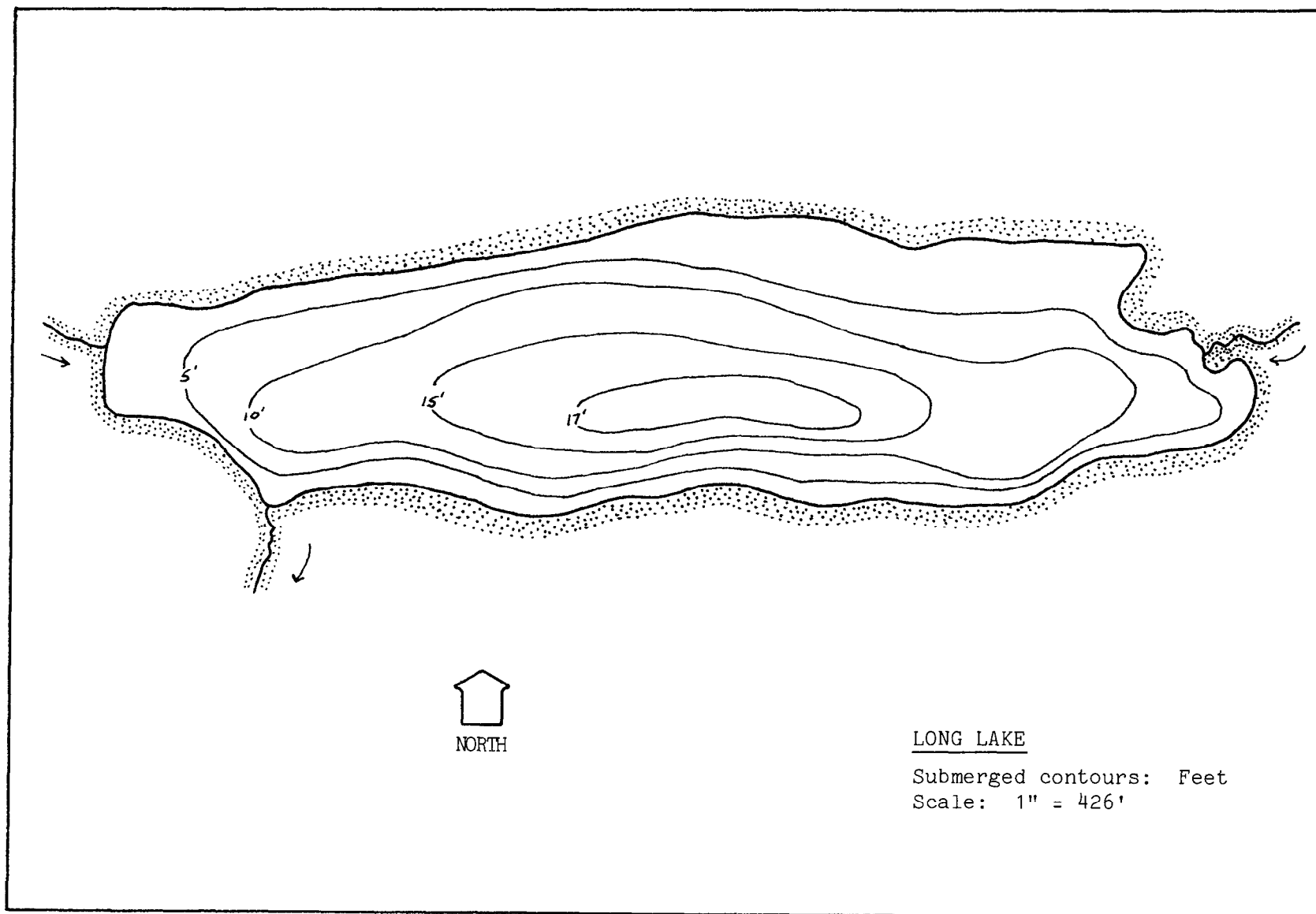
Appendix Figure 1. Mirror (Mud) Lake contour map.



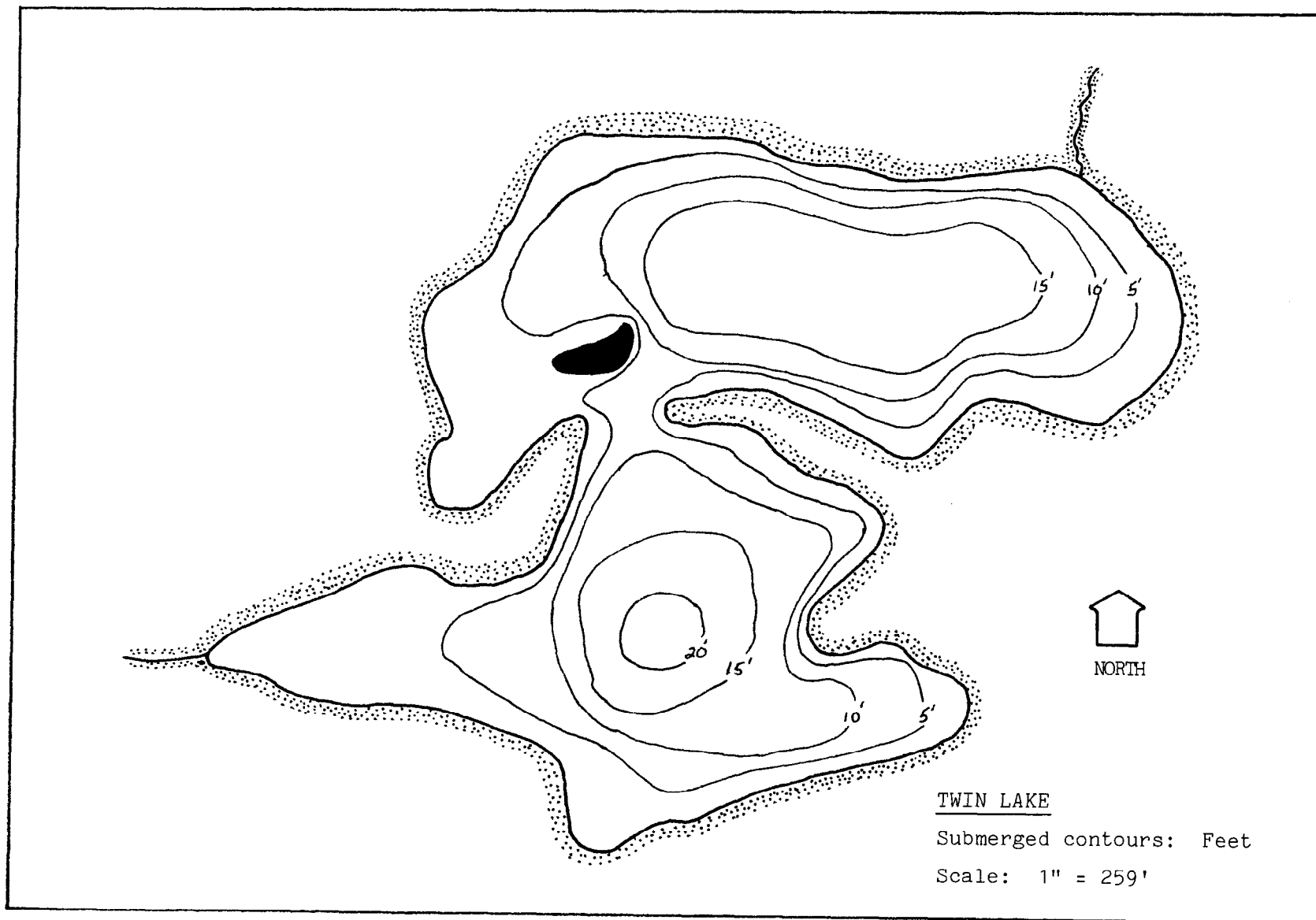
Appendix Figure 2. Lloyd's Pond (Root Beer Lake) contour map.



Appendix Figure 3. Flat Lake contour map.



Appendix Figure 4. Long Lake contour map.



Appendix Figure 5. Twin Lake contour map.

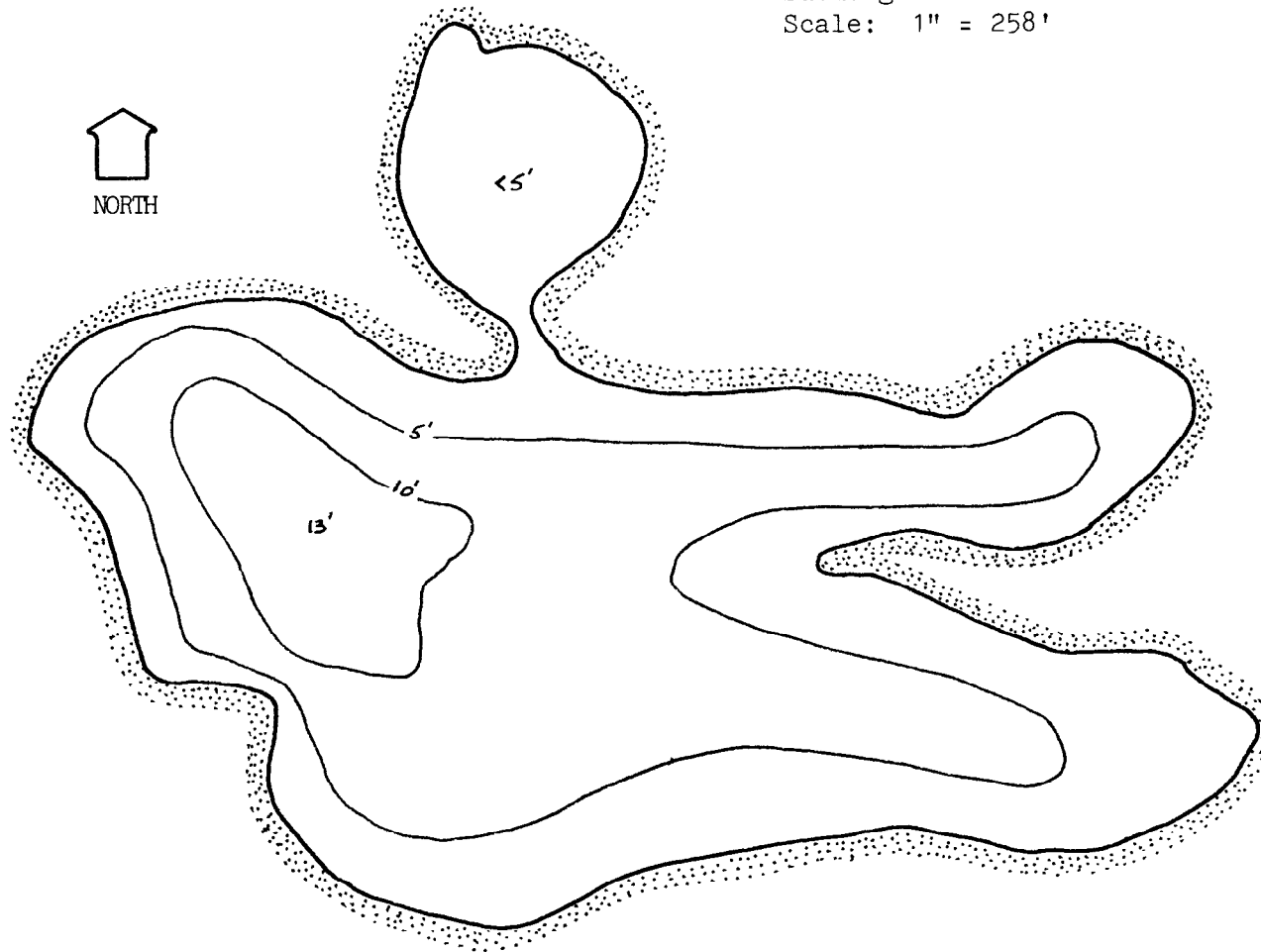
LAZY LAKE

Submerged contours: Feet

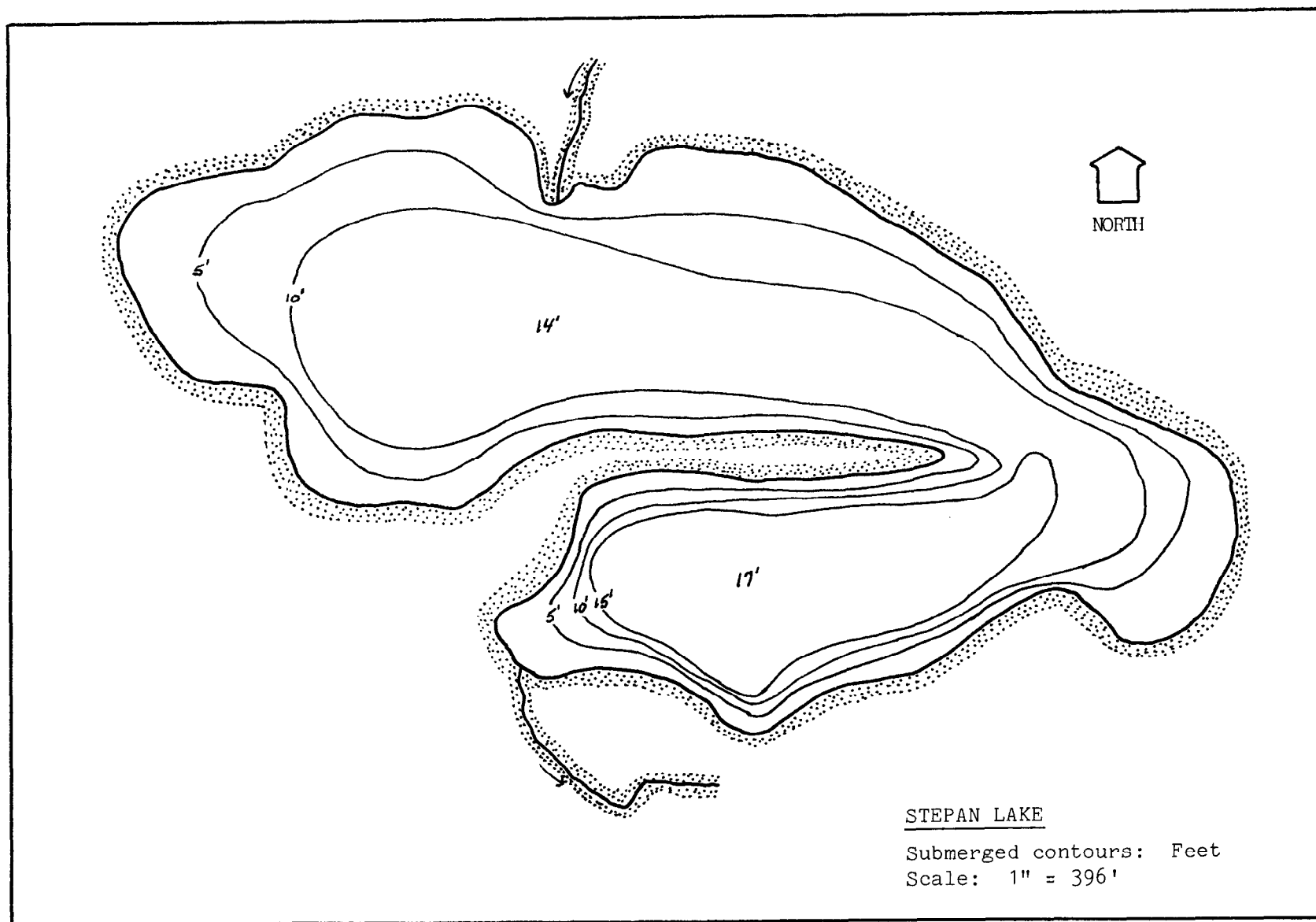
Scale: 1" = 258'



NORTH



Appendix Figure 6. Lazy Lake contour map.



Appendix Figure 7. Stepan Lake contour map.

